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# Scaling out Climate Smart Agriculture

Strategies and Guidelines for Smallholder Farming  
in Western Kenya

Michaela Schaller, Elena Barth, Darinka Blies, Felicitas Röhrig,  
Malte Schümmelfeder





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## Seminar für Ländliche Entwicklung | Centre for Rural Development

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SLE Postgraduate Studies on International Cooperation for  
Sustainable Development

PUBLICATION SERIES S 269

*Study commissioned by  
Advisory Service on Agricultural Research for Development (BEAF) of  
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in coopera-  
tion with the International Center for Tropical Agriculture (CIAT) and  
GIZ Western Kenya*

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Berlin, April 2017

*Supported by*



Federal Ministry  
for Economic Cooperatio  
and Development

**giz** Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH



**be** **Berlin**

Senate Department for  
Economics, Energy  
and Public Enterprises

## **SLE PUBLICATION SERIES S 269**

Editor	<p>Humboldt-Universität zu Berlin SLE Postgraduate Studies on International Cooperation for Sustainable Development</p> <p>Hessische Str. 1-2 10115 Berlin Germany</p> <p>Phone: +49 30 2093-6900 FAX: +49 30 2093-6904</p> <p>E-Mail: <a href="mailto:sle@agrar.hu-berlin.de">sle@agrar.hu-berlin.de</a> Website: <a href="http://www.sle-berlin.de">www.sle-berlin.de</a></p>
Backstopper	<p>Christian Berg Anja Kühn</p>
Print	<p>Zerbe Druck&amp;Werbung Planckstr. 11 16537 Grünheide Germany</p>
Distribution	<p>SLE Hessische Str. 1-2 10115 Berlin Germany</p>
Photographs	<p>SLE team</p>
Copyright	<p>2017 by SLE</p> <p>1<sup>st</sup> Edition 2017 (1-150)</p> <p>ISSN 1433-4585</p> <p>ISBN 3-936602-80-8</p>

## Preface

The Centre for Rural Development (SLE – Seminar für Ländliche Entwicklung), Humboldt-Universität zu Berlin, has trained young professionals in the field of German and international development cooperation for more than fifty years.

Six-month empirical and applied research projects conducted on behalf of German or international development agencies are an integral part of the one-year postgraduate course. With interdisciplinary teams and the guidance of experienced team leaders, young professionals carry out assignments on innovative future-oriented topics, providing consultant support to the commissioning organizations. Here the involvement of a diverse range of actors in the process is of great importance, i.e., surveys range from household level to decision-makers and experts at national level. The outputs of this applied research contribute directly to solving specific development problems.

The studies are mostly linked to rural development themes and have a socio-economic focus, such as the improvement of agricultural livelihoods or regimes for sustainable management of natural resources. The host countries are mostly developing or transformation countries, but also fragile states. In the latter, topics such as disaster prevention, peace building and relief are also under review. Another study focus lies in the field of method development or of handbooks and guidelines. Evaluation, impact analysis and participatory planning belong likewise in this category.

Throughout the years, SLE has carried out more than two hundred consulting projects in approximately ninety countries and regularly publishes the results in this series. In 2016, SLE teams completed four studies in Ethiopia, Kenya, and Peru.

The present study is *Scaling out Climate Smart Agriculture – Strategies and Guidelines for Smallholder Farming in Western Kenya*. The study was commissioned by the Advisory Service on Agricultural Research for Development (BEAF) of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

The report is also available from the SLE on request and downloadable from the SLE-website.

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## Acknowledgements

We would like to express our sincere appreciation to the many people and organizations that contributed to the successful realization of this study. Our special thanks go first of all to Dr. Holger Kirscht from the Advisory Service on Agricultural Research for Development (BEAF) of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for commissioning and accompanying the study. The International Center for Tropical Agriculture in Nairobi and GIZ Western Kenya and their partners supported our field work in Kenya with scientific, practical and logistical assistance.

We would like to especially thank Dr. Rolf Sommer, head of the soil health group, and Juliet Braslow, coordinator of soil research at CIAT, for their continuous input and feedback on research objectives, methods and scientific state-of-the-art. We enjoyed the lively and helpful discussions with the various CIAT staff members, including Dr. Caroline Mwongera and Dr. Boaz Wazwa. We would also like to thank Wanjiku Kiragu and the administrative staff, as well as Dr. Birthe Paul for their commitment to logistic issues. Special thanks go to John Mukalama, in charge of the regional CIAT office at Maseno, Western Kenya, for sharing his experience of long-term fieldwork related to CSA. We very much appreciated the opportunity of attending a workshop given by Dr. Lucy Emerton on ELMO – our main research tool: the Evaluating Land Management Options method developed by CIAT.

We would also like to express our gratitude to Dr. Gerrit Gerdes, programme manager at GIZ Western Kenya, and his team for the friendly welcome and manifold support throughout our fieldwork: special thanks go to Flora Ajwera, senior soil staff member, and county programme coordinators Evans Asena and Dennis Ncurai for their valuable support in the counties, especially their mobilization of extension officers and interview partners from the regional counterparts. Ruth Niedermüller provided tireless assistance throughout our workshops and Sarah Maiyo and her team from Welthungerhilfe shared valuable expertise for our fieldwork. Thanks also go to Arshfod Njenga and colleagues, who gave expert advice on our technical factsheets.

Further, we would like to thank the agricultural county officials – particularly County Minister of Agriculture, Hon. Kulati Wangia, and Director of Agriculture, Mr. Isaac Munyendo – for supporting our research and for their willingness to grant us interviews. Our warmest appreciation goes to the extension officers who assist-

## iv Acknowledgements

ed our fieldwork, notably Christabel Makari, Adelaide Muyembe, Kery Majhalla, John Awalo, Kazi Odour, Ron Okere and Stephen Otieno. We also cordially thank all the farmers and their families who agreed to be interviewed, as well as all the other experts – including those from IASS Potsdam, Vi Agroforestry, the Climate Smart Village in Nyando and the regional Agricultural Training Centers – who shared their knowledge or infrastructure with us.

Last but not least, we would like to express our special thanks to the SLE director, Dr. Susanne Neubert, and the entire SLE staff with special reference to Anja Kühn and Christian Berg for their valuable advice, feedback and support throughout the preparation and realization of this study.

## Executive summary

### Background information

Climate change (CC) has become a reality and challenges all nations to adapt to changing climate conditions, on the one hand, and contribute to their mitigation, on the other. The risks of climate change for developing countries, including Kenya, are generally seen as high due to their high vulnerability to extreme weather events and their low capacity for adaptation. Agriculture, and rain-fed agriculture in particular, is considered a CC sensitive sector as a result of its weather dependence, but also contributes to CC in the form of greenhouse gas emissions, notably in high-input agriculture.

Agriculture in Kenya plays a crucial role in the economy with more than 60% of the population employed in the agricultural sector. The predominantly small-scale agricultural activities are particularly vulnerable to climate change impacts due to the limited possibilities of coping with these changes. Rising temperatures of at least 2°C and changes in precipitation patterns in terms of quantity, intensity and distribution are the projected effects of climate change (CC) in Kenya. Extreme weather events such as droughts, floods and heat waves will occur with greater frequency and intensity, and lead to a shift in growing seasons and, ultimately, in agro-ecological zones.

### Core problem of the study area

The counties of Siaya and Kakamega are located in the Western Kenyan highlands close to Lake Victoria where the effects of climate change are magnified by the influence of the basin. Here farmers produce maize, beans, sorghum, millet, sweet potato and tea mainly through rain-fed agriculture. Productivity in both counties, however, lies way below the estimated potential. With a yield of 1.3 tons of maize per hectare and less than 5 litres of milk per cow and day, Kenyan productivity barely reaches 30% of the world-wide average.

In addition to low productivity, soils are overexploited due to inadequate management and continuous use without sufficient nutrient replenishment. In the absence of soil protection measures, soil erosion is widespread and likely to increase significantly as a result of projected changes in climate conditions in the region. The depletion of organic matter inevitably leads to the release of CO<sub>2</sub> and thus to a higher CO<sub>2</sub> concentration in the atmosphere. In addition, soil degradation reduces the already low agricultural productivity, threatening food security in the process. This intensifies the political, institutional and financial challenges facing

the Kenyan authorities, as they continue to struggle with the process of devolution. In recent years, responsibilities have been transferred from the national to the regional, i.e., to the county authorities. A number of new council authorities are not yet fully functional, however, which has an adverse effect on the administration of agricultural extension services and the support for sustainable agricultural development programmes.

For smallholder farmers in Kenya, implementing measures for soil conservation and CC adaptation unaided poses a challenge. Furthermore, not all have the same starting conditions, with women's poor access to productive resources, capital and advisory services defined as a gender gap. Yet another aspect is the weak agricultural extension service. Underfinanced, underequipped and lacking the required training, the extension service is not in a position to develop strategies for soil conservation and CC adaptation. The curricula in Kenyan agricultural training centres barely touch on the topic of soil management or the rehabilitation of soils and water resources. Adequate training material, in particular, is a scarce commodity.

### **Scope of the study**

The study was commissioned by the Advisory Service on Agricultural Research for Development (BEAF) of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and was carried out in cooperation with GIZ Western Kenya and the International Centre for Tropical Agriculture (CIAT) in Nairobi. Overall objective of the study was to design a strategy and make recommendations for locally adapted climate smart agriculture (CSA) tailored to smallholder needs in Western Kenya. This included the production of practical policy and technical guidance material.

According to the specific needs and interests of the commissioning and collaborating parties, the team selected three priority research areas as entry points for integrated action and coordination:

1. the policies and frameworks for CSA implementation in Kenya, and Western Kenya in particular,
2. the farm level perspective on CSA in Western Kenya,
3. the linkage between scientific agricultural research and its practical application at farm level via (public) extension and/or other advisory services.

## **Theoretical frameworks of the study**

### **Climate smart agriculture**

Agricultural development and food security are high on the global policy agenda. Population growth and low productivity put pressure on competition for natural resources such as land, energy and water, and pose increasing challenges for agriculture, especially in developing countries. The adverse effects of climate change on food production prospects are felt most by the rural poor. In response, the international community came up with the concept of *Climate Smart Agriculture* (CSA), an approach that aims to achieve three goals simultaneously, in line with the three concept pillars: i) to increase productivity and incomes sustainably, ii) to adapt and build resilience to climate change from farm to national level, and iii) to mitigate the effects of climate change by reducing greenhouse gas emissions or, where possible, by increasing carbon sequestration in agriculture.

In order to identify and compare the climate smartness of the different techniques, some stakeholders have begun to develop technical indicators. The indicators measure the technological potential of the various agricultural practices in terms of their ability to contribute to increasing productivity, climate adaptation and mitigation in a region-specific context. Generally, they measure positive changes following implementation of CSA technologies in six relevant categories: *water, energy, carbon, nitrogen, weather, and knowledge smartness*.

Numerous activities have been launched around the globe to promote research and CSA implementation. Yet, the concept has also earned much criticism at grassroots level and raised concerns about the lack of adequate definitions and guidelines to accompany the concept of CSA, which could leave the door wide open for environmentally damaging practices. These concerns highlight the need to come up with clear-cut definitions, standards and guidelines (safeguards or exclusions) that clarify what is regarded as CSA and what is not.

In the broad sense, therefore, CSA extends beyond the adoption of individual climate smart agricultural technologies at farm level. It calls for the simultaneous integration of locally adapted complementary techniques and management strategies that together create synergies and contribute to achieving the three CSA goals. Taking this seriously involves integrated action at farm and landscape level if large-scale resilience and mitigation effects are to be achieved.

### **Innovation diffusion**

For the adoption of climate smart techniques, the concept of innovation diffusion is likewise of crucial importance. According to prevailing opinion, there are four main elements in the diffusion of new ideas: (i) the innovation itself, (ii) communication channels, (iii) time and (iv) the context or social system. Diffusion of innovation usually starts slowly and few people are convinced at the outset. Diffusion is based on the adopter's individual needs, as well as on aspects such as location, media and neighbours. The uptake of a specific technology depends greatly on the social and economic status of the individual concerned and is interlinked with risk assessment or risk management. Socio-economic constraints constitute one of the biggest challenges when it comes to the low diffusion levels of modern agricultural technologies. These can be lack of financial inputs, lack of awareness or increasing subdivision of land into uneconomic units.

Similar to many other developing countries, the extension service in Kenya is key to the diffusion of technical information to small-scale farmers. It facilitates the adoption of new technologies and the adaptation of innovations to local conditions. In other words, the extension service tailors technologies to local needs and farming circumstances. It can enhance human capital and transfer knowledge by providing training and information.

Other important issues apart from the vital function of the extension service are linked to farmers' – horizontal and hierarchical – social networks, as reflected in the value of co-learning, upscaling through entrepreneurship, and innovation brokerage.

### **Methodology**

The team designed a mixed-method research approach that includes elements from Participatory Rural Appraisal (PRA), such as focus group discussions, individual interviews and household-level participatory tools from the Evaluating Land Management Options (ELMO) method. ELMO is a participatory tool designed by CIAT to assess farmers' own perceptions of and explanations for the advantages, disadvantages and trade-offs associated with different land management choices.

Fieldwork took place in the counties of Siaya and Kakamega in Western Kenya. Most parts of these two counties are located in the lower midland altitude range and can be divided into two major agro-ecological zones (AEZ), a semi-arid to transitional AEZ in Siaya around Lake Victoria and a semi-humid to humid AEZ in the direction of Kakamega. Smallholders and extension officers were the most

important survey units during fieldwork. The selection criteria for the first group were: male and female smallholders; subsistence farmers and commercial farmers; farmers who had already applied selected CSA techniques and those who had not. For the selection of ten extension officers per AEZ, the team sought the assistance of local counterparts from GIZ Western Kenya.

The research also drew from supplementary interviews with experts from the political arena, academia and local or international advising agencies working on CSA implementation in the area. Research results were treated as qualitative data and embedded in the policy framework analysis for CSA implementation at county and national level, including an extended literature review prior to field research.

## **Results of the study**

### **Existing policies and prioritization frameworks for CSA implementation**

Within the international frameworks on climate change and agriculture, Kenya signed a multitude of treaties and is a member of all major agreements on climate protection and adaptation, including the African CSA Alliance. Climate change is high on the Kenyan national agenda, with the government frequently proclaiming climate change a major challenge of the future – especially for agriculture. The Kenya CSA Framework Programme is the core document for current and future implementation of CSA in Kenya. It focuses on increased productivity followed by resilience building, with mitigation clearly in third place. The Programme also emphasizes the need for enhanced coordination of the actors concerned in order to improve vertical and horizontal integration.

#### *Devolution*

With the 2010 amendment to the constitution, most Kenyans voted for decentralization. Accordingly, legislative and executive power was transferred to the 47 Kenyan counties as of 2013, whereas judicial power remained at national level. Devolution fundamentally altered how things are implemented in Kenya and it is crucial to understand these changes in order to design a feasible strategy for the upscaling of CSA.

#### *County Level*

Neither Kakamega nor Siaya use the exact term Climate Smart Agriculture in their County Integrated Development Plan (CIDP) – their primary development instrument. Siaya, however, has prioritized components of CSA under the term Conservation Agriculture, indicating that adaptation is a key element of Siaya pol-

itics. Putting CSA on Siaya's agenda calls for emphasis on the close connection to sustainable food production. Kakamega has also shown interest in the CSA concept, notably when this is linked to existing priorities such as productivity growth.

### **CSA from a farm level perspective**

#### *The relevance of CSA pillars in the Kenyan smallholder context*

In the Kenyan context, the CSA focus lies on increasing productivity and strengthening resilience to climate change. At the same time, attempts have been made to tackle the potential of mitigation even in the Kenyan smallholder context: pilot projects aim for carbon sequestration in smallholder farming with a view to potential income-generating sources for smallholders, who can then tap into funds raised by the Voluntary Carbon Market. The low financial inputs, however, made it impossible to demonstrate the benefits of improved farming techniques and act as an incentive. Smallholders showed a clear preference for CSA techniques directed at productivity growth and resilience. For this reason, the study saw mitigation merely as a potential co-benefit when it came to choosing CSA techniques and practices suitable for local adaptation.

#### *Changing weather conditions*

Farmers' perception of climate smart techniques is based on a coherent grasp of changing weather conditions. Overall, the more prevalent changes include altered rainfall patterns, with rainy season begin, duration and intensity becoming more unpredictable; higher occurrences of dryspells or droughts and drying out of streams and rivers; higher frequency of floods; higher temperatures and stronger winds. These changes – notably in precipitation – impact negatively on farm production and lead to yield losses, crop failure, low productivity particularly in live-stock breeding and, on the whole, a growing sense of uncertainty.

#### *Locally adapted CSA techniques*

In order to cope with changing weather conditions, farmers are already in the process of applying a number of climate smart techniques. In total, farmers prioritized thirteen technologies, nine of which were chosen in both counties, while the remaining four were chosen either in Kakamega or in Siaya. The climate smart techniques favoured by both counties included agroforestry, certified seeds, compost/use of manure, conservation agriculture, crop rotation, intercropping, mulching/cover crops, push-pull, and terracing. Enhanced fodder management and live-stock breeds were selected exclusively in Siaya and soil testing & liming and water harvesting only in Kakamega. It is worth noting, that almost all of the techniques



chosen by the farmers have a medium to medium-high score in climate smartness – in particular with regard to adaptation.

Key results from the ELMO interviews indicate that all farmers had a strong preference for CSA techniques compared to a no-CSA scenario; there was no clear preference for one or more techniques; although benefits and uses were ranked high, costs and disadvantages prevented farmers from applying CSA; an enhanced food supply and quick returns were among the highest smallholder priorities in terms of technology adoption; bought inputs were the biggest obstacle, whereby local availability of material posed a greater challenge than the actual cost; trade-offs from resource allocation were a further challenge, with different rankings by female and male farmers.

#### *When is a farm climate smart?*

Since CSA is an integrative approach, farmers must choose and integrate a smart combination of techniques in accordance with their own capacity to create synergies across different productivity, adaptation and mitigation targets. While numerous technique combinations are possible, the present study suggests adhering to the following recommendations for the design of a climate smart farm. According to the concept of climate smart villages in Nyando, Western Kenya, a farm is considered climate smart if it uses technologies and practices from each of the following categories: soil and water conservation structures; integration of perennial and annual crops; improved livestock enterprises; diversification of enterprises; farm plan readiness.

#### **Research/extension linkage**

A healthy research/extension linkage sees strong cooperation and communication between the main stakeholders, namely, research organizations, the extension service and farmers. Research passes on its results to the extension service, which translates them into farm-level language, trains farmers in new technologies and informs them of new inputs. At the same time, extension can report farm level difficulties back to research, where research – ideally involving the farmers themselves – is adjusted and delivered to the targeted beneficiaries, the farmers.

#### *Relevant actors in Kenya*

Kenya Agricultural and Livestock Research Organisation (KALRO) is the most important Kenyan research organization relevant to agriculture. Results reach regional extension officers via capacity building and the Ministries of Agriculture and are archived in KALRO's web-based database and its library. CIAT as an ex-

ample of an independent international research organization translates its academic information to the practical level through the “proof of concept to implementation” approach, beginning with trials in various locations followed by field demonstrations and ending with scaling-up strategies.

Extension officers (EOs) work towards enhanced food security by helping farmers at all stages, expressly by ensuring the correct execution of steps to adopt a new, e.g., climate smart, technique. Extension officers help farmers to make the right choice of practices and support their implementation and subsequent maintenance. The structure of the extension service did not change in Kenya after devolution. Its management did, however, resulting in an interruption of the information flow. Further reasons for lack of information are: the adverse support ratio, whereby a small number of EOs is responsible for a large number of farmers; lack of CSA training material and the absence of a direct distribution channel; unclear communication channels following devolution. Moreover, findings from research organizations such as KALRO or CIAT are not reflected in the training curriculum.

### **Discussion of results**

On the whole, the results indicate that CSA outscaling on a grand scale can only be successful if agricultural education and training services in the region are improved and extended so that farmers are equipped with the necessary skills and knowledge to make informed decisions. In this context, lessons learnt from the Innovation Diffusion Theory stress the importance of: 1. a thorough and adequate knowledge transfer, 2. farmer guidance throughout the adoption process and 3. raising the number of multipliers, e.g., by model farmers and farmer-to farmer extension.

At the same time, however, results indicate that some barriers to CSA adoption are more structural in nature and need to be addressed on a broader scale. This includes unfavourable market conditions as well as policy and institutional obstacles such as lack of infrastructure and poor service quality, all of which further define the conditions under which decisions are made. Unless stronger emphasis is put on addressing the challenges farmers are facing at all levels, CSA implementation in Western Kenya may not be successful.

Then, while the results and recommendations may provide some good entry-points into how to promote the outscaling of climate smart technologies in Western Kenya, a number of fundamental challenges and open questions with reference to specific technology choices and their effectiveness remain. Despite the

development of indicators to compare the climate smartness of one technology with another, there is no generally acknowledged threshold or guiding principle to ultimately declare an entire farm, let alone an agricultural sector, climate smart.

Even with a full package of CSA techniques, farmers have no guarantee that the techniques involved will make their farms resilient enough to deal with the upcoming challenges of climate change. This underlines the importance of further research and highlights the need to complement any efforts to promote climate smart techniques with safety schemes, including insurance schemes to reduce the risk of crop and income losses, and measures to support farmers during the implementation phase until such time as they can reap the benefits of their investments.

CSA is gaining considerable momentum on the international agenda, not least because it is seen as the ideal track on which to achieve ambitious agricultural mitigation targets at global level. At the same time, developing and lower middle-income countries like Kenya are clearly concentrating on increasing productivity and improving climate change adaptation. If mitigation, the third CSA pillar, is set aside, the practical difference between CSA and previous concepts remains blurry.

## **Recommendations**

### **General considerations**

Designing a coherent and comprehensive CSA strategy at county level calls for identification and coordination of multiple activities and stakeholders across the agricultural sector and their alignment with national and county level development goals. Broadly put, this type of strategy consists of several building blocks, each representing a sector (or thematic area such as policy level, the private sector, research & extension level) that demands specific action before the outscaling of locally suitable CSA practices can be established. The information gathered on the status quo and opportunities and shortcomings in each building block allow us to design a strategy that sees entry points identified, activities prioritized, and responsibilities and financial means allocated to the respective decision-makers.

### **Prioritization of action**

The study clearly showed that county governments must act as the prime catalysts when it comes to creating a policy environment for large-scale implementation of CSA. Given that CIDPs are their most important planning tool, the inclusion and mainstreaming of CSA as a priority development goal for the agricultural sector in these policy documents constitutes an important first step. This allows for

access to and allocation of funds from the national government to promote CSA at county level. Hence the approach chosen for CSA needs to be aligned with other national and county-level development goals such as food security, employment creation and economic growth.

Once this policy framework has been established, county governments need to prioritize the institutions to be strengthened. Given the weaknesses identified in the (Western) Kenyan extension system, a key priority is to invest in extension service management in general, and in capacity building and extension officer training in particular. In parallel, the government should invest in targeted research activities that deal with the cost efficiency and effectiveness of climate smart techniques, as well as enhanced infrastructure, including information and communication technology.

Once the extension service is equipped with the relevant information and the means to reach and advise farmers, the latter can make informed decisions on investments in climate smart farming activities. The evidence shows that farmers still face sizeable barriers and uncertainties with reference to technology adoption. The provision of credits and insurance schemes to reduce the risk of making investments under uncertainty and the improved access to material inputs and well-functioning markets are some significant examples. Addressing and overcoming the more structural barriers to technology adoption, however, can take time and effort to achieve. It demands a strategy that facilitates the transition phase, drawing on policy tools such as input subsidies, price guarantees and community-based saving and credit schemes.

## Zusammenfassung

### Hintergrundinformation

Der fortschreitende Klimawandel (KW) ist mittlerweile eine globale Herausforderung und stellt alle Länder vor die Notwendigkeit der Anpassung sowie des Beitrags zum Klimaschutz. Für Entwicklungsländer, einschließlich Kenia, gelten Risiken durch den KW auf Grund der hohen Vulnerabilität gegenüber Extremereignissen sowie der niedrigen Anpassungskapazität als hoch. Die Landwirtschaft, v.a. der Regenfeldbau, ist auf Grund der Wetterabhängigkeit einerseits ein sensibler Sektor gegenüber dem KW und trägt andererseits durch die Emission von Treibhausgasen – insbesondere in der Intensivlandwirtschaft – wiederum zu Klimaveränderungen bei.

In Kenia – wie in allen afrikanischen Ländern – spielt die Landwirtschaft eine wichtige bis sehr wichtige Rolle für die Wirtschaft des Landes und mehr als 60% der Bevölkerung sind im landwirtschaftlichen Sektor tätig. Insbesondere die kleinbäuerliche Landwirtschaft ist gegenüber dem KW anfällig, da sie nur über begrenzte Möglichkeiten zur Anpassung verfügt. Für Kenia betragen die erwarteten Auswirkungen des KW ansteigende Temperaturen von mindestens 2 °C sowie Veränderungen in der Menge, Intensität und Verteilung der Niederschläge. Extremereignisse wie Dürren, Überflutungen und Hitzewellen werden mit größerer Häufigkeit und Intensität auftreten. Dies wird die Anbauperioden und letztendlich die agrarökologischen Zonen verschieben.

### Kernproblem und Untersuchungsregion

Die Landkreise ("counties") Siaya und Kakamega liegen im Hochland Westkenias in unmittelbarer Nachbarschaft zum Viktoriasee. Durch den Viktoriasee werden die Auswirkungen des KW verstärkt. Bauern in beiden Regionen produzieren Mais, Sorghum, Hirse, Süßkartoffel und Tee im Regenfeldbau. Die landwirtschaftliche Produktivität liegt in beiden Counties weit unter dem Potential: Mit nur 1,3 t Mais pro Hektar und weniger als 5 l Milch am Tag pro Kuh erreicht die Produktivität kaum 30% des weltweiten Durchschnitts.

Zusätzlich zur geringen Produktivität sind die Böden auf Grund von mangelhaften Bewirtschaftungspraktiken und Dauernutzung ohne ausreichende Zufuhr von Nährstoffen übernutzt. Erosion ist bei fehlenden Schutzmaßnahmen verbreitet und wird vermutlich durch den KW in der Region weiter zunehmen. Die Verarmung an organischer Substanz führt zu einer Freisetzung von CO<sub>2</sub> und damit

einer höheren Konzentration in der Atmosphäre. Bodendegradierung reduziert die ohnehin niedrige landwirtschaftliche Produktivität und bedroht folglich die Ernährungssicherheit. Dies verstärkt politische, institutionelle und finanzielle Herausforderungen für kenianische Behörden, die ohnehin noch mit dem Dezentralisierungsprozess kämpfen. In den letzten Jahren wurden Verantwortlichkeiten von der nationalen auf die regionale Ebene, d.h. County-Ebene, verlagert. Allerdings sind noch nicht alle County-Behörden vollkommen funktionstüchtig, was die Administration des landwirtschaftlichen Beratungsdienstes und die Unterstützung von nachhaltigen landwirtschaftlichen Entwicklungsprogrammen beeinträchtigt.

Für Kleinbauern stellt die Implementierung von notwendigen Maßnahmen für den Bodenschutz und die Anpassung an den KW mit eigenen Mitteln eine Schwierigkeit dar. Außerdem haben nicht alle die gleichen Voraussetzungen, wobei der geringere Zugang von Frauen zu produktiven Ressourcen, Kapital und Beratungsdiensten als „Gender-Gap“ bezeichnet wird. Eine weitere Herausforderung stellt der geschwächte landwirtschaftliche Beratungsdienst dar, der nicht in der Lage ist, Strategien für den Bodenschutz und die Anpassung an den Klimawandel zu entwickeln, da er nicht gut für diese Aufgaben ausgebildet, finanziert und ausgestattet ist. Zudem umfassen die Lehrpläne landwirtschaftlicher Beratungszentren kaum Themen wie Bodenmanagement und Wiederherstellung von Boden- und Wasserressourcen. Insbesondere fehlt hierzu adäquates Trainingsmaterial.

### **Zielsetzung der Studie**

Die Beratungsgruppe für entwicklungsorientierte Agrarforschung der Deutschen Gesellschaft für Internationale Zusammenarbeit (GIZ-BEAF) hat die vorliegende Studie beauftragt, die in Kooperation mit GIZ Westkenia sowie dem Internationalen Zentrum für Tropische Landwirtschaft (CIAT) in Nairobi durchgeführt wurde. Ziel der Studie ist, eine Strategie und Empfehlungen für lokal angepasste, klima-smarte Landwirtschaft für Kleinbauern in Westkenia zu entwickeln. Dies beinhaltet auch die Erstellung von Briefing Materialien zu technischen und politischen Fragestellungen.

Entsprechend der spezifischen Interessen und Bedarfe des Auftraggebers sowie der Partner wählte das Team drei prioritäre Forschungsgebiete für die Implementierung von klima-smarter Landwirtschaft:

1. Politiken und Rahmenbedingungen für CSA-Implementierung in Kenia und Westkenia im Speziellen,
2. die CSA-Perspektive der Farmebene in Westkenia,

3. der Link zwischen agrarwissenschaftlicher Forschung und praktischer Anwendung auf Farmebene mithilfe des (staatlichen) Beratungsdienstes.

## **Konzeptioneller Rahmen**

### *Klima-smarte Landwirtschaft*

Die landwirtschaftliche Entwicklung und Ernährungssicherheit stehen weit oben auf der globalen politischen Agenda. Das Bevölkerungswachstum und die geringe Produktivität erhöhen die Konkurrenz um natürliche Ressourcen wie Land, Energie und Wasser und erhöhen die Herausforderungen für die Landwirtschaft, insbesondere der Entwicklungsländer. Die Auswirkungen des Klimawandels verschlechtern weiterhin die Chancen für eine produktive Landwirtschaft, was insbesondere die arme Landbevölkerung trifft. Als Antwort darauf hat die internationale Gemeinschaft das Konzept der klima-smarten Landwirtschaft entwickelt, das darauf abzielt, drei Ziele gleichzeitig zu erreichen – entsprechend der drei Säulen des Konzeptes:

- i) die nachhaltige Steigerung von Produktivität und Einkommen,
- ii) die Anpassung an und Resilienz Bildung gegenüber dem Klimawandel von Farm- bis nationaler Ebene und
- iii) Beitrag zum Klimaschutz durch die Reduktion von Treibhausgasen oder der erhöhten Kohlenstoffsequestrierung in der Landwirtschaft, wo möglich.

Einige Stakeholder haben begonnen, technische Indikatoren zu entwickeln, um verschiedene Techniken in Bezug auf ihre Klima-Smartness identifizieren und vergleichen zu können. Diese Indikatoren messen das Potenzial verschiedener landwirtschaftlicher Praktiken in Bezug auf ihre Fähigkeit, zu gesteigerter Produktivität, Anpassung und Klimaschutz in einem regionalen Kontext beizutragen. Im Allgemeinen messen diese Indikatoren positive Veränderungen durch die Implementierung von CSA-Techniken in Bezug auf sechs relevante Kategorien, wie Wasser-, Energie-, Kohlenstoff-, Stickstoff-, Wetter- und Wissens-Smartness.

Rund um den Globus wurden zahlreiche Aktivitäten gestartet, die die Forschung zu und die Implementierung von CSA fördern. Andererseits hat das Konzept von Basisorganisationen auch viel Kritik geerntet in Bezug auf fehlende Definitionen und Richtlinien, was umweltschädlichen Praktiken eine Hintertür öffnen könnte. Diese Bedenken unterstreichen den Bedarf, klare Definitionen, Standards und Richtlinien für CSA zu entwickeln.

CSA im weiteren Sinne geht über die Übernahme von individuellen klima-smarten landwirtschaftlichen Techniken auf Farmebene hinaus. Es bedarf der

gleichzeitigen Integration lokal angepasster komplementärer Techniken und Management Strategien, die zusammen Synergieeffekte generieren und dazu beitragen, die drei Ziel von CSA zu erreichen. Dabei sind für die konsequente Umsetzung integrierte Aktionen auf Farm- und Landschaftsebene notwendig, um eine höhere Resilienz und die Reduktion von Treibhausgasemissionen (Mitigation) im großen Stil zu erreichen.

### **Ausbreitung von Innovationen**

Für die Übernahme von klima-smarten Techniken ist des Weiteren entscheidend, welches Konzept für die Ausbreitung der Innovationen umgesetzt wird. Entsprechend vorherrschender Meinung gibt es vier Hauptelemente bei der Ausbreitung neuer Ideen: i) die Innovation, ii) die Kommunikationswege, iii) Zeit und iv) der Kontext bzw. das soziale System. Die Ausbreitung von Innovationen beginnt üblicherweise langsam und nur wenige potentielle Anwender können davon überzeugt werden. Die Ausbreitung hängt von den individuellen Bedarfen des Anwenders sowie Kriterien wie Lokalität, Medien und Nachbarn ab. Dabei ist die Übernahme mit der jeweiligen Beurteilung und dem Management von Risiken eng verbunden und hängt eng mit dem sozialen und ökonomischen Status der betreffenden Person ab. Dabei fungieren sozioökonomische Einschränkungen in Bezug auf geringe Übernahmeraten moderner landwirtschaftlicher Techniken als große Herausforderung. Diese können auf einem Mangel an finanziellen Mitteln, an Bewusstsein oder auch zunehmender Landzersplitterung in unwirtschaftliche Einheiten beruhen.

In Kenia, wie in vielen Entwicklungsländern, stellt der landwirtschaftliche Beratungsdienst einen wichtigen Transfer dar, um technische Informationen zu verbreiten. Er unterstützt die Übernahme neuer Technologien und die Anpassung von Innovationen an maßgeschneiderte, lokale Bedingungen. Der Beratungsdienst kann durch die Bereitstellung von Training und Wissen Informationen weitertragen und Humankapital bilden.

Weitere wichtige Multiplikatoren sind bäuerliche soziale Netzwerke – sowohl horizontale als auch hierarchische – was sich in der Bedeutung gemeinsamen Lernens, der Verbreitung durch Unternehmertum als auch als „Innovationsbrokerage“ widerspiegelt.

### **Methodik**

Neben der Literaturstudie stellte das Studienteam einen Methodenmix für die Feldforschung zusammen, der Elemente der partizipativen landwirtschaftlichen



Erhebung, wie Fokusgruppendifkussionen, Einzelinterviews sowie partizipative Instrumente der ELMO- (Evaluating Land Management Options-) Methode auf Haushaltsebene beinhaltet. ELMO ist ein Tool, das von CIAT entwickelt wurde, um einschätzen zu können, wie Bauern selber Vor-, Nachteile und Zielkonflikte verschiedener Landnutzungsoptionen wahrnehmen und erklären.

Die Feldforschung fand in den Counties Siaya und Kakamega in Westkenia statt. Der größte Teil der Counties liegt in mittleren Höhenlagen und kann in zwei agrar-ökologische Zonen unterteilt werden: eine weitgehend semiaride Zone in Siaya um den Viktoriassee gelegen und eine semihumide bis humide Zone in Richtung Kakamega. Die wichtigsten Untersuchungseinheiten stellten Kleinbauern und Angestellte des landwirtschaftlichen Beratungsdienstes dar. Auswahlkriterien für die erste Gruppe waren: männliche und weibliche Kleinbauern; Subsistenz- sowie kommerziell orientierte Bauern; und Bauern, die bereits CSA-Techniken anwandten und solche, die dies nicht taten. Die zehn Berater pro Zone wurden mit Hilfe der lokalen Counterparts von GIZ ausgewählt.

Die Studie beinhaltet auch komplementäre Interviews mit weiteren Experten aus Politik, Forschung und lokalen sowie internationalen Beratungseinrichtungen, die zu CSA-Umsetzung in der Region arbeiten. Alle Forschungsergebnisse wurden qualitativ ausgewertet und in eine Analyse der politischen Rahmenbedingungen für die Umsetzung von CSA auf County und nationaler Ebene eingebettet.

## **Studienergebnisse**

### **Politiken und Rahmenbedingungen für die Priorisierung von CSA**

Kenia hat eine Reihe von internationalen Verträgen zu Klimaschutz und Landwirtschaft unterzeichnet und ist Mitglied aller relevanten Vereinbarungen zu Klimaschutz und Anpassung, wie z.B. der Afrikanischen CSA-Allianz. Der Klimawandel und seine Herausforderungen – insbesondere für die Landwirtschaft – hat auch Eingang in bzw. Bedeutung für die nationale Agenda gefunden. Das nationale CSA-Rahmenprogramm ist das Kerndokument, das alle momentanen und zukünftigen Schritte zur Implementierung von CSA anleitet. Es fokussiert auf die Steigerung der Produktivität gefolgt von Resilienzstärkung und Reduzierung von Emissionen; wobei Letzteres eine nachgeordnete Säule darstellt. Es betont zudem die Notwendigkeit einer besseren Koordinierung relevanter Akteure sowohl in horizontaler als auch vertikaler Richtung.

### *Devolution – Übertragung administrativer Unabhängigkeit*

Mit der Änderung der Verfassung im Jahr 2010 stimmte die Mehrheit der Kenianer für eine Dezentralisierung. In der Folge wurde die legislative und exekutive Macht an die 47 Counties übertragen. Die Devolution hat die Implementierungswege in Kenia fundamental verändert und es ist wichtig, diese Veränderungen zu verstehen, um eine realistische Strategie für eine umfassende Etablierung von CSA zu entwickeln.

### *County-Ebene*

Weder Kakamega noch Siaya verwenden den Begriff der klima-smarten Landwirtschaft in ihren integrierten County-Entwicklungsplänen (CIDPs). Diese stellen das wichtigste Planungsinstrument dar. Allerdings hat Siaya CSA-Komponenten unter dem Begriff der konservierenden Landwirtschaft priorisiert. Dies bedeutet, dass Anpassung ein wichtiges Element der Politik in Siaya darstellt. Um CSA auf die politische Agenda von Siaya zu bekommen, ist es wichtig, einen stärkeren Bezug zur nachhaltigen Nahrungsmittelproduktion herzustellen. In Kakamega besteht ebenso Interesse am CSA-Konzept; insbesondere, wenn es mit bestehenden Prioritäten, wie der Produktivitätssteigerung in Zusammenhang gebracht wird.

### **Die Perspektive der Farmebene auf CSA**

#### *Die Bedeutung der CSA-Säulen im Kontext kenianischer Kleinbauern*

Im kenianischen Kontext liegt der Schwerpunkt von CSA auf der Steigerung der Produktivität und Resilienz gegenüber dem Klimawandel. Es gibt jedoch auch Bestrebungen, das Emissionsreduzierungspotential selbst im kleinbäuerlichen Kontext in Angriff zu nehmen: Pilotprojekte zielen auf Kohlenstoffspeicherung (Sequestrierung) ab, die erhöhte Einkommen für Kleinbauern mithilfe des freiwilligen Kohlenstoffmarktes generieren könnte. Allerdings sind die finanziellen Mittel nicht ausreichend, um einen Anreiz für verbesserte Bewirtschaftungstechniken darzustellen und die Kleinbauern bevorzugten eindeutig CSA-Techniken, die auf eine Verbesserung der Produktivität und Resilienz setzen. Für die Auswahl von geeigneten und lokal angepassten CSA-Praktiken zogen die Autoren der Studie Techniken zur Reduzierung der Treibhausgasemissionen deshalb nur als möglichen zusätzlichen Nutzen in Betracht.

#### *Sich wandelnde Wetterverhältnisse*

Die Wahrnehmung klima-smarter Techniken von Bauern basiert auf einer klaren Wahrnehmung sich verändernder Wetterbedingungen. Insgesamt umfassen die vorherrschenden Veränderungen folgende Parameter: sich verändernde Nie-

derschlagsmuster, wobei sowohl der Beginn, die Länge als auch die Intensität von Regenzeiten größeren Unsicherheiten unterliegt; vermehrtes Auftreten von Trockenzeiten und Dürren wie auch Austrocknen von Wasserläufen; erhöhte Häufigkeit von Überflutungen; höhere Temperaturen und stärkere Winde. Diese Veränderungen – insbesondere die Niederschlagsveränderungen – beeinträchtigen die landwirtschaftliche Produktion und führen zu Ernteaussfällen, geringerer Produktivität, auch in der Viehzucht, sowie insgesamt zunehmenden Produktionsrisiken.

### *Lokal angepasste CSA-Techniken*

Um mit den sich ändernden Wetterbedingungen besser zurecht zu kommen, wenden die Bauern bereits heute einige klima-smarte Anbautechniken an. Insgesamt priorisierten die Bauern 13 Techniken, wobei neun in beiden Counties und die verbleibenden vier in einem der beiden Counties favorisiert wurden. Die gemeinsamen Favoriten beinhalteten: Agroforstsysteme; zertifiziertes Saatgut; Kompost/Düngeranwendung; Konservierende Bodenbearbeitung; Fruchtfolge; Zwischenfruchtanbau; Mulchen/Bodenbedeckung; „Push-Pull“ und Terrassierung. In Siaya wurden zusätzlich verbessertes Futtermanagement und verbesserte Zuchtrassen ausgewählt, in Kakamega dagegen Bodenproben & Kalken sowie Wasserspeicherung. Bemerkenswert ist, dass sich fast alle der bereits angewandten Techniken durch mittlere bis hohe Werte in Klimasmartness auszeichnen – insbesondere in Bezug auf Anpassung.

Die ELMO-Interviews führten zu folgenden zentralen Ergebnissen: Alle Bauern bevorzugten CSA-Techniken im Vergleich zu „Nicht-CSA“-Szenarien; es gab keine klare Präferenz für eine oder mehrere Techniken; obwohl Nutzen und Vorteile einzelner Techniken hoch bewertet wurden, verhindern ihre Kosten und Nachteile doch ihre Anwendung; verbesserte Nahrungsversorgung und schnelle Renditen zählten zu den höchsten Prioritäten der Farmer in Bezug auf die Übernahme einer Technik; gekaufte Investitionen waren die wichtigste Barriere für die Implementierung einer Technik, wobei häufig die fehlende lokale Verfügbarkeit von Materialien ein größeres Hindernis als ihre Kosten bildete; außerdem stellten Zielkonflikte bezüglich der Ressourcenallokation ebenfalls eine Herausforderung dar. Männer und Frauen unterschieden sich hier in ihrem Ranking.

### *Wann ist eine Farm klima-smart?*

Da CSA als integrativer Ansatz gedacht ist, ist es notwendig, dass ein Bauer verschiedene Kombinationen von Techniken entsprechend ihrer Vorteile in Hinblick auf Produktivitäts-, Anpassungs- und Mitigationsziele wählt und in sein Gesamtmanagement integriert. Während zweifelsohne zahllose Kombinationen mög-

lich sind, schlägt die vorliegende Studie vor, sich bei dem Design einer klimasmarten Farm an die folgenden Empfehlungen zu halten: entsprechend des Konzeptes der klima-smarten Dörfer in Nyando, Westkenia, wird eine Farm als klima-smart betrachtet, wenn sie Technologien und Managementpraktiken aus jeder der folgenden Kategorien befolgt:

- boden- und wasserkonservierende Strukturen,
- Integration von mehrjährigen (perennen) und einjährigen (annuellen) Kulturarten,
- verbesserte Viehwirtschaft,
- Diversifizierung der Bewirtschaftung und
- die Erarbeitung eines Managementplanes für die Farm.

### **Der Weg von der Forschung über die Beratung in die Anwendung**

Ein guter Anwendungsbezug besteht in einer guten Kooperation und Kommunikation zwischen den Hauptakteuren, namentlich Forschungsorganisationen, dem Beratungsdienst und Bauern. Forschungsergebnisse werden an den Beratungsdienst übermittelt, der diese dann in leicht verständliche Sprache und Praktiken übersetzt und die Bauern in diesen schult. Gleichzeitig berichten Vertreter des Beratungsdienstes über Schwierigkeiten in der Anwendungspraxis, die zurück in die Forschung eingespeist werden.

#### *Relevante Akteure in Kenia*

Die kenianische Forschungseinrichtung zu Landwirtschaft und Viehzucht (KALRO – Kenya Agricultural and Livestock Research Organisation) ist die wichtigste nationale landwirtschaftliche Forschungseinrichtung. Ihre Forschungsergebnisse werden an regionale Berater mithilfe von Weiterbildungen vermittelt und in der KALRO eigenen Web-basierter Datenbank und Bibliothek archiviert. CIAT als Beispiel einer unabhängigen internationalen Forschungseinrichtung übersetzt akademisches Wissen in die praktische Anwendung durch sein Testverfahren, das mit Felduntersuchungen unter verschiedenen Umweltbedingungen startet, Feldbegehungen beinhaltet und schließlich mit Strategien für die fortschreitende Umsetzung endet.

Der landwirtschaftliche Beratungsdienst dient der Verbesserung der Nahrungssicherheit, indem er die Bauern in allen Phasen – insbesondere bei der korrekten Durchführung von Schritten für die Übernahme von z.B. klima-smarten

Techniken – unterstützt. Er unterstützt die Bauern bei der Wahl von Praktiken, ihrer Implementierung und nachfolgender Beibehaltung. Die Struktur des kenianischen Beratungsdienstes hat sich unter der Dezentralisierung nicht verändert. Allerdings hat sich das Management verändert, was zu einem unterbrochenen Informationsfluss führt. Weitere Gründe für einen Mangel an Information sind: ein ungünstiges Betreuungsverhältnis; ein Mangel an Trainingsmaterial, wobei auch die Verteilungs- und Kommunikationswege infolge der Dezentralisierung unklar sind. Zudem werden aktuelle Forschungsergebnisse von z.B. KALRO oder CIAT nicht in die Ausbildung eingespeist.

### **Diskussion der Ergebnisse**

Insgesamt zeigen die Ergebnisse, dass die Verbesserung und Erweiterung landwirtschaftlicher Bildungs- und Trainingsangebote in der Region für die großflächige Implementierung von CSA ausschlaggebend sind. Damit die Bauern die notwendigen Fähigkeiten und das notwendige Wissen erlangen, um wissensbasierte Entscheidungen zu treffen, muss den Lehren der Innovationsverbreitungstheorie zufolge: 1. Ein gründlicher und angemessener Informationstransfer erfolgen; 2. Die Bauern durch den gesamten Prozess begleitet werden; und 3. die Zahl der Multiplikatoren, z.B. auch durch Modell-Bauern, und gegenseitiges Lernen erhöht werden.

Gleichzeitig sind einige der Barrieren für Innovationsübernahmen anscheinend eher struktureller Art: sie basieren auf Faktoren, die auf einer höheren Ebene betrachtet werden müssen. Hierzu gehören z.B. ungünstige Marktbedingungen, politische und institutionelle Barrieren wie u.a. mangelhafte Infrastruktur und schlechte Qualität von Dienstleistungen. Ohne alle diese Faktoren mit zu berücksichtigen, wird die großflächige Implementierung von CSA in Westkenia aus Sicht der Autoren daher wohl nicht erfolgreich sein.

Schließlich bleiben noch eine Reihe grundsätzlicher Herausforderungen bestehen und Fragen bezüglich der Auswahl spezifischer Techniken und ihrer Effektivität in Hinblick auf eine klima-smarte Landwirtschaft offen. Während Indikatoren entwickelt werden, die erlauben, einzelne Techniken untereinander zu vergleichen, gibt es bisher keine allgemein anerkannte Schwelle oder Richtlinie, die klar indiziert, wann eine ganze Farm, geschweige denn der landwirtschaftliche Sektor als klima-smart gelten kann.

Zudem gibt es für den Bauern/die Bäuerin, selbst wenn er bzw. sie klima-smarte Techniken anwendet, keine Sicherheit, dass die gesamte Farm ausreichend resilient gegenüber zukünftigen Klimaveränderungen sein wird, da bisheri-

ge Voraussagen hinsichtlich zukünftiger Klimaveränderungen eher sehr unsicher sind. Dies unterstreicht einerseits die Bedeutung weiterer Forschung und zeigt gleichzeitig die Notwendigkeit auf, zusätzliche Sicherheitsnetze einzubeziehen, wie z.B. Versicherungsleistungen, die gegenüber Ernteverlusten und Einkommensausfällen absichern sowie Maßnahmen, die den Bauern in der Umsetzungsphase unterstützen, bis sich die Investitionen amortisiert haben.

CSA erfreut sich auf der internationalen Agenda einer beträchtlichen Dynamik – nicht zuletzt, weil es als Pfad gesehen wird, um ambitionierte Klimaschutzziele im Agrarsektor zu erreichen. Allerdings liegt der Fokus von Entwicklungs- und Schwellenländern wie auch Kenia auf der Steigerung der Produktivität und der Resilienz. Wenn die Reduzierung von Treibhausgasen jedoch außer Acht gelassen wird, stellt sich die Frage, inwieweit CSA auch in Zukunft, wenn Kenia womöglich ebenfalls zu einem wichtigen Treibhausgasemittenten in der Landwirtschaft geworden ist, dann noch eine umfassende Lösungsstrategie sein wird.

### **Empfehlungen**

#### **Generelle Überlegungen**

Eine kohärente und umfassende CSA-Strategie auf County Ebene zu entwerfen, beinhaltet die Identifizierung und Koordination vielfältiger Aktivitäten und Akteure sowie die Abstimmung nationaler und regionaler Entwicklungsziele. Vereinfachend besteht solch eine Strategie aus verschiedenen Säulen, die jeweils einen Sektor repräsentieren (oder Themenfeld, wie z.B. Politik, privater Sektor und Wissenschaft und Beratung), in denen jeweils spezifische Aktionen notwendig sind, um geeignete CSA-Praktiken zu etablieren. Aufbauend auf dem Status quo, Chancen und Limitierungen in jeder Säule, kann eine Strategie entwickelt werden, indem Hebelpunkte identifiziert werden, Aktivitäten priorisiert und Verantwortlichkeiten und Finanzmittel den jeweiligen Entscheidern übertragen werden.

#### **Priorisierung von Aktivitäten**

Die Studie hat klar aufgezeigt, dass die County-Regierung als Katalysator fungieren könnte, um das nötige Politikumfeld für die großflächige Etablierung von CSA zu schaffen. Dafür stellt die Integration von CSA in das wichtigste Planungsinstrument, die CIDPs (County Integrated Development Plan), einen wichtigen ersten Schritt dar. Dies erlaubt den Zugriff auf Finanzmittel der Zentralregierung und deren Einsatz für die Förderung von CSA. Dabei sollte CSA mit weiteren nationalen und regionalen Entwicklungszielen, wie z.B. Ernährungssicherheit, die Schaffung von Arbeitsplätzen und wirtschaftliches Wachstum abgestimmt werden.

Sobald der politische Rahmen etabliert ist, sollten die County-Regierungen priorisieren, welche Institutionen gestärkt und unterstützt werden sollen. In Anbetracht der Defizite des landwirtschaftlichen Beratungsdienstes in (West-) Kenia liegt eine erste Priorität in der Stärkung sowohl des Managements als auch der Weiterbildung und im Training des Mitarbeiterstabes. Parallel hierzu sollten die Kosteneffizienz und Effektivität der verschiedenen klimasmarten Techniken untersucht werden. Zudem besteht Bedarf im Hinblick auf die Verbesserung der Infrastruktur, einschließlich der Informations- und Kommunikationstechnologien.

Sobald der Beratungsdienst besser ausgerüstet ist, um die Bauern zu erreichen und zu beraten, können Letztere informationsbasierte Entscheidungen im Hinblick auf klima-smarte Bewirtschaftungsaktivitäten treffen. Allerdings ist offensichtlich, dass Bauern darüber hinaus mit erheblichen Hindernissen und Unsicherheiten in Bezug auf die Übernahme von Innovationen konfrontiert sind. So stellt die Bereitstellung von Krediten und Versicherungsmöglichkeiten eine wichtige Maßnahme dar, um die Risiken, Entscheidungen unter Unsicherheiten treffen zu müssen, zu reduzieren. Weitere wichtige Faktoren sind der verbesserte Zugang zu Betriebsmitteln und gut funktionierende Märkte. Da diese Maßnahmen Zeit benötigen, ist es wichtig, mit gezielten, zeitlich begrenzten Subventionen, Preisgarantien oder kommunalen Kreditsystemen die Übergangsphase zu erleichtern.





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## Abbreviations

AEZ	Agro-ecological zone
ASDSP	Agricultural Sector Development Support Programme
ATVET	Agriculture Technical Vocational Education and Training
BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CC	Climate Change
CD	Capacity Development
CIDP	County Integrated Development Plan
CIAT	International Centre for Tropical Agriculture
CGIAR	Consultative Group on International Agricultural Research
CSA	Climate Smart Agriculture
ELMO	Evaluating Land Management Options
FAO	Food and Agriculture Organization of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
GIZ-BEAF	Beratungsgruppe Entwicklungsorientierte Agrarforschung der Deutschen Gesellschaft für Internationale Zusammenarbeit (Advisory Service on Agricultural Research for Development)
GoK	Government of Kenya
KALRO	Kenya Agricultural and Livestock Research Organisation
MOALF	Ministry of Agriculture, Livestock and Fisheries
SEWOH	Sonderinitiative EINEWELT Ohne Hunger (Special Initiative One World, No Hunger)
SLE	Seminar für Ländliche Entwicklung (Centre for Rural Development)



# **1 Introduction**

## **Background**

The GIZ Advisory Service for Agricultural Research and Development (BEAF) in cooperation with GIZ Western Kenya and the Centre for Tropical Agriculture in Nairobi (CIAT) commissioned the Centre for Rural Development (SLE) to carry out this study.

Kenya is a focus country of the German Federal Ministry for Economic Cooperation and Development (BMZ) SEWOH Initiative (One World, No Hunger), with GIZ as one of the implementing partners. Two SEWOH components are implemented in Western Kenya: soil protection and rehabilitation for food security and green innovation centres for the agricultural and food sector. Both projects show strong links to the concept of Climate Smart Agriculture (CSA). As part of the Consultative Group on International Agricultural Research (CGIAR), CIAT focuses on applied research on CSA.

The study contributes to the development of strategies and guidelines to promote the adoption of CSA techniques by smallholders in Western Kenya, i.e., in the counties of Siaya and Kakamega.

## **Basic socio-economic data on Kenya**

With a Human Development Indicator (HDI) of 0.548, Kenya ranks 145<sup>th</sup> in the world (UNDP, 2015). Approximately 65% of Kenya's population is employed in the agricultural sector. This showcases the tremendous significance agriculture holds for key issues at the heart of development: food security, poverty reduction, sustainable livelihoods.

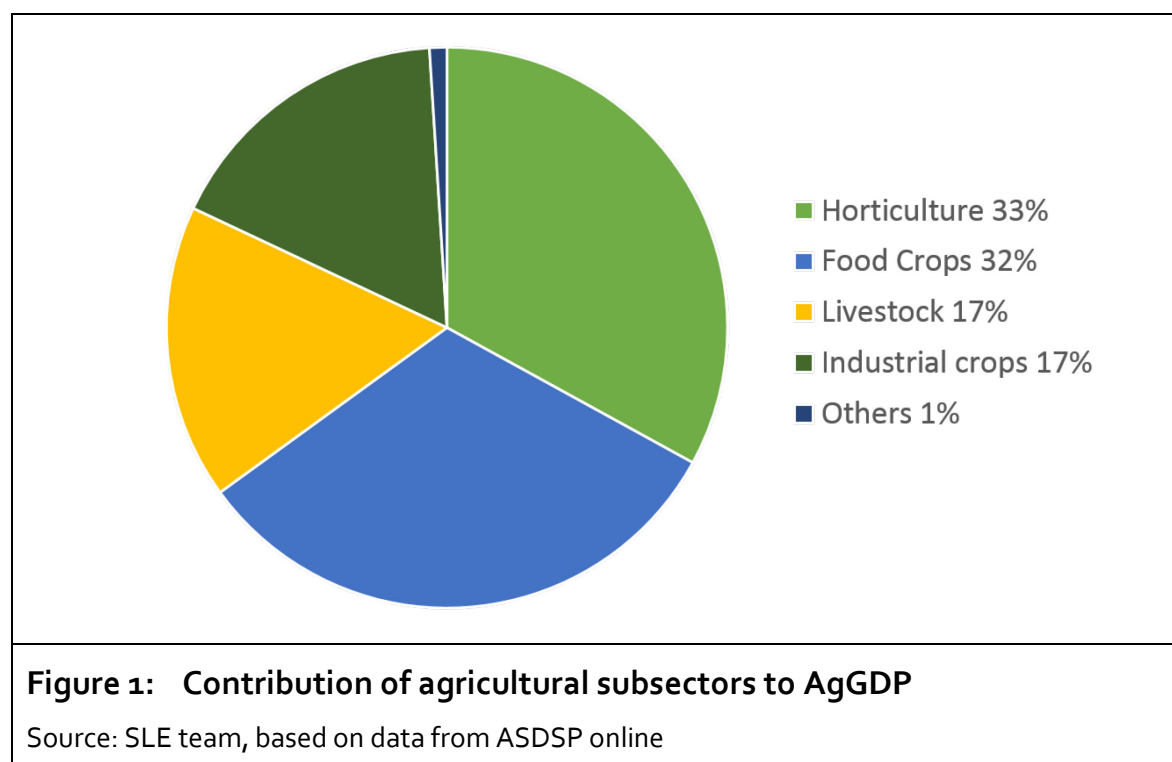
Kenya is a youthful country, where roughly half the population is 18 years of age or younger. Youth is concentrated in the rural areas, while their proportion in urban areas is significantly lower. Data from 2009 shows that almost 50 per cent of the population (45.2%) lives below the poverty line defined by the World Bank. Of the 38 million people in Kenya, 4.7 million are primarily engaged in small-scale agriculture and pastoral activities. The Kenyan population is unevenly distributed, with densities substantially higher in the central region around Nairobi and in Western Kenya (Wiesmann et al., 2014).

### Agricultural production and climate change in Kenya

#### Agricultural production in Kenya and in the study area

Agriculture plays a crucial role in the Kenyan economy. 65% of Kenyan exports come from the agricultural sector and add up to 80% of the country's export earnings and approximately 65% of the employment rate in this sector. Agriculture thus contributes more than 50% to the annual GDP, with a combination of farming activities (25%) and agriculture-related activities (25%) such as the processing of agricultural products. This results in a high correlation of Kenya's general economic growth and the well-being of the agricultural sector (Government of Kenya, 2010a).

Kenya's agricultural production structure incorporates six subsectors classified according to the principal products, i.e., industrial crops, food crops, horticulture, livestock, fisheries and forestry.



Horticulture and food crop products make up 65% of the national agricultural GDP (AgGDP) (33% horticulture; 32% food crops) followed by livestock and others. Products from the industrial crop subsector, i.e., cash crops such as tea, coffee, sugar cane, cotton, sunflowers, pyrethrum, barley, tobacco, sisal and coco-



nut, are predominantly designed for export, where they account for more than 50% of agricultural exports, while their contribution to the national AgGDP is almost negligible.

This study focuses on food crops, horticulture and livestock in two rural counties in Western Kenya, both of which are dominated by small-scale agricultural activities. The counties of Kakamega and Siaya cover a total area of 6,585 km<sup>2</sup> (Siaya: 3,535 km<sup>2</sup>; Kakamega: 3,050 km<sup>2</sup>), approx. 60% of which is arable land (ASDSP online). Agricultural production in the two counties is similar in terms of crop types and techniques used, but differs in quantity notably in the livestock subsector. Farmers in both counties produce maize, beans, sorghum, millet, sweet potatoes and tea for the most part through rain-fed agriculture, albeit in radically different quantities. In the livestock subsector of Siaya, for example, where almost 80% of households own livestock, production largely exceeds that of Kakamega. Productivity in both counties, however, lies way below the estimated potential. With only 1.3 tons of maize yield per hectare and less than 5 litres of milk per cow and day, Kenyan productivity in this sector barely reaches 30% of the global average (ASDSP online; World Bank and CIAT, 2014).

### **Climate and climate change in Kenya and the study area**

The climate in Kenya spans from oceanic along the coast to hot semi-arid towards the northwest of the country (climate-data.org online). The study region of Western Kenya is characterized by a semi-humid to humid climate for Kakamega and the northern part of Siaya, while the southern part of Siaya is semi-arid to transitional (Jaetzold et al., 2010).

Precipitation rates and available water resources in this area are relatively high compared to other regions of Kenya. Hence the western rural areas play a major role in the national agricultural sector. Despite favourable conditions, however, population growth, changing human settlement patterns, expanding urban environments and unsustainable agricultural practices and land-use systems pose serious threats to the environment and the dependent agricultural systems across the region (ASDSP online). These stressors are aggravated by the effects of ongoing climate change. Due to their high vulnerability to extreme weather events and low adaptation capacity, developing countries face considerable challenges in terms of high climate risks. Specifically, Kenya is one of the countries most threatened by climate change (Okoti, 2015). The majority of its economic activities relies on climate-sensitive natural resources. This holds true in particular for

## 4 Introduction

the agricultural sector, which depends heavily on seasonal rainfall (Government of Kenya, 2013b).

The projected effects of climate change (CC) are rising temperatures of at least 2 °C by the middle and end of the 21st century compared to the 1981-2000 average (Niang et al., 2014), along with changes in precipitation patterns in terms of quantity, intensity and distribution. Extreme weather events such as droughts, floods and heat waves will happen with greater frequency and intensity, leading to a shift in growing seasons and ultimately of agro-ecological zones (Williams et al., 2015). Notably in Western Kenya, rising temperatures impact heavily on rainfall patterns. The Lake Victoria basin adds to the regional impacts of climate change. Recent observations show that the rise in the average water temperature of Lake Victoria leads to irregular rainfall patterns, especially in Western Kenya, while higher evaporation rates greatly intensify the short rainy seasons from October to December (Thornton et al., 2010).

These intensified rainy seasons are predicted to cause severe productivity losses and increased soil erosion. Surplus water resources are confined to the rainy seasons and cannot be utilized for constant irrigation due to the absence of water harvesting and conservation infrastructure in the region. This leads to a deterioration in the already fragile situation of the rural population, which is in turn struggling with low agricultural productivity, the result of low soil fertility, acidification and soil erosion coupled with land shortage and limited access to inputs and markets. Hence climate change magnifies the threat to the rural population of Western Kenya of reduced food security and income (Nachmany et al., 2015). On the other hand, while agriculture is one of the sectors heavily affected by CC, it is also responsible for 33% of Kenya's greenhouse gas (GHG) emissions, thereby accelerating CC (Würtenberger et al., 2012). This also illustrates the vast potential of CC mitigation for the agricultural sector.

### **Gender**

In Kenya, women and men perform different roles in agriculture. The so-called gender gap sees women with less access to productive resources, capital and advisory services compared to men. Traditionally women are forbidden to carry out certain activities in a specific regional context, e.g., planting trees (it would at least be highly unusual for them to do so) (World Bank et al., 2009; Tengnas 1994).

Throughout Kenya, 32% of households are female-headed, with higher values in rural sublocations (e.g., Siaya with 45% of female-headed households) (Wiesmann et al., 2014). While women perform most of the work in the agricultural sector and produce most of the food, their share of the income is a fraction of what

men earn from agriculture. The possibility for women to own, buy or control property is limited. Consequently, most female-headed households suffer from poverty or extreme poverty (FSD online).

Thus, when it comes to introducing new technologies, women and men are active on an uneven playing field; men have an advantage from the start. This will clearly impact substantially on innovation adoption and household decision-making, calling for a gender-responsive approach to the projects concerned, one that enhances agricultural productivity, food security and nutrition, and well-being – and ultimately benefits both men and women (World Bank et al., 2009).

### **Core problem of the study area**

The counties of Siaya and Kakamega are located in the Western Kenyan highlands close to Lake Victoria, where the effects of climate change are intensified by the influence of the basin. The dominant smallholder farming set-up, with typical farm sizes between 0.6 and 1.0 ha (1.5–2.5 acre) and mixed livestock and crop activities is particularly prone to current and projected climate changes as a result of the limited capacity to cope with these changes (ASDSP online). Precisely because of the small scale of most farming systems, temporal shortages cannot be easily overcome and even partial crop failures or yield losses constitute an existential threat to farmers, who mostly rely on their farms for subsistence.

In addition to low productivity, soils are overexploited due to inadequate management and continuous use without the necessary nutrient replenishment. In the absence of soil protection measures, soil erosion is widespread and likely to increase significantly as a result of the projected changes in climate conditions in the region (Government of Kenya, 2013b). The depletion of organic matter inevitably leads to a release of CO<sub>2</sub> and thus to a higher concentration in the atmosphere. Soil degradation reduces the already low agricultural productivity, threatening food security in the process. Since Western Kenya is crucial to Kenya's agricultural sector, these problems are not confined to the region but affect the whole country.

Against this backdrop, the Kenyan authorities face serious political, institutional and financial challenges, in addition to their ongoing struggle with the devolution process. In recent years, responsibilities have been transferred from the national to the regional, i.e., to the county authorities. Some of the new council authorities are not yet fully functional, however, which has had an adverse effect on the administration of agricultural extension services and their support for sustainable agricultural development programmes.

## 6 Introduction

Smallholders in Kenya may find it challenging to implement the necessary measures for soil conservation and CC adaptation unaided. Nationwide adoption of climate resilient techniques at farm level requires a strategy that takes each government decision-making level into account and includes the farmers themselves in the process. Since the final decision on adopting innovative techniques lies with the farmers, the strategy must be tailored in such a way as to provide them with a favourable environment and political framework, information and incentives, and access to materials for the adoption and implementation of new techniques.

Yet another challenge is the weak agricultural extension service. Untrained, underfinanced and underequipped, it does not have the capacity to develop and outscale strategies for soil conservation and adaptation to CC. Neither do topics such as soil management and the rehabilitation of soils and water resources find an echo in the curricula of Kenyan agricultural training services. Adequate training material is a notably rare commodity.

## 2 Objectives and scope of the study

The overall objective of the study is to contribute to the development of strategies and guidelines for locally adapted climate smart agriculture (CSA) that is tailored to smallholder needs in Western Kenya. This includes the production of practical, technical and policy guidance material.

According to Cattaneo et al. (2012), a CSA strategy is based on the coordination of multiple activities and stakeholders, namely, (i) its adoption by farmers, (ii) the provision of financial assistance for climate smart activities, (iii) the definition of coherent policies and (iv) the generation and dissemination of information. This again demands an assessment of the current agricultural situation and an understanding of the barriers to adoption of CSA practices, as well as the identification of favourable conditions for CSA implementation and policy recommendations.

According to the specific needs and interests of the commissioning parties, the team selected three priority research areas as entry points for integrated action and coordination:

1. the policies and frameworks for CSA implementation in Kenya, and Western Kenya in particular
2. the farm-level perspective of CSA in Western Kenya
3. the linkage between scientific agricultural research and its practical application at farmlevel via (public) extension and/or other advisory services

### *Ad 1. Policies and frameworks*

To obtain an overview of the problem setting it was vital to analyse existing policies and frameworks for CSA implementation at both national and county level. Barriers and success factors were identified in order to delineate the conditions to be established at local, regional and national level for the adoption of CSA practices. As a first step this involved identifying relevant actors, their strategies and their previous and current projects within the scope of promoting CSA practices in Kenya. Given the large number of existing initiatives and actors, the SLE team identified those with most relevance for the Western Kenyan context and explored the lessons to be drawn from their experience.

### *Ad 2. Farm-level perspective*

As a second focus area, the team examined the farm-level perspective of CSA in Western Kenya. This constituted the main body of research and involved identifying suitable CSA techniques for the study area via collecting and evaluating the

## 8 Objectives and scope of the study

different experiences, perceptions and opinions of farmers and other stakeholders at local level (county representatives, extension officers and local NGO staff). The data collected referred specifically to the concept itself and CSA technologies. The study aimed to explore and discuss aspects such as technical feasibility, costs and benefits, and socio-cultural and institutional factors (e.g., gender or outreach of extension service) that might influence the ability and willingness of farmers to adopt CSA techniques. Thus, the study sought to identify bottlenecks and good practice examples of CSA implementation, and to extract recommendations at both the technical and the policy level. These recommendations focus on empowerment with success factors and encouragement with solutions to obstacles.

### *Ad 3. Research extension linkage*

To complete the picture, a third thematic focus addressed the linkage between the scientific research level and the practical farm level with reference to CSA implementation. This part of the research drew on the experience, perceptions and needs of extension officers and other advisory agents (e.g., from NGOs), and their ability to learn about and translate scientific recommendations on CSA technologies into the practical language of smallholder farmers. In this context, the SLE team had a look at the state of existing knowledge transfer channels in the study area from the science to the extension level and from the extension to the farm level.

## **2.1 Research questions**

According to the thematic areas, the team addressed the following research questions:

1. What is the status quo of CSA implementation at county level and national level? What constitutes a suitable CSA prioritization and implementation strategy?
2. Are regional stakeholders aware of the concept of CSA?
3. How do farmers perceive CSA practices in Western Kenya?
4. What are suitable incentives and requirements to increase the adoption or attractiveness of CSA?
5. What is the relevance and specification of the three pillars of CSA in the local smallholder context?

## **2.2 Products**

In addition to this major study, research results are documented in a policy brief and five technical factsheets on selected CSA techniques. While the policy brief deals with framework conditions, the hands-on technical factsheets for extension agents contain tailored information on locally adapted techniques for implementation of CSA on the ground. Disseminated by partners of the study, notably GIZ Western Kenya and its counterparts, fact sheets will contribute to a smoother implementation of CSA practices and thus to a broader adoption of climate smart techniques.





### 3 Theoretical framework

#### 3.1 Climate smart agriculture

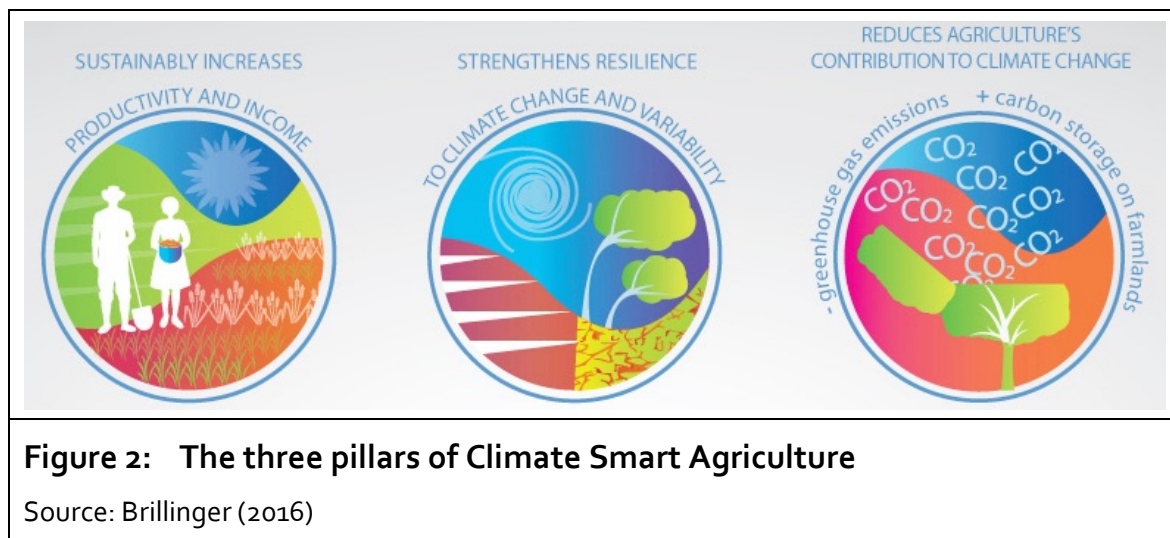
This first chapter of the theoretical framework addresses the concept of climate smart agriculture, its theoretical background and its relevance in the Kenyan smallholder context. In addition, it reflects on the international debate on the pros and cons of CSA in comparison with other land management approaches.

##### 3.1.1 What is climate smart agriculture?

Agricultural development and food security are high on the global policy agenda. Population growth and low productivity put pressure on the competition for natural resources such as land, energy and water, and pose increasing challenges for agriculture, notably in developing countries. The adverse effects of climate change worsen the prospects for food production and are felt most by the rural poor. Against this background, the principal idea behind the Sustainable Development Goals is to “end hunger, achieve food security and improved nutrition and promote sustainable agriculture”, to “ensure availability and sustainable management of water” and to “take urgent action to combat climate change and its impacts” (Williams et al., 2015: i). To address these dimensions of sustainable development simultaneously is one of the major challenges facing agriculture in the coming decades.

The international community responded with the concept of *Climate Smart Agriculture* (CSA), which promises to address these challenges and “reflects an ambition to improve the integration of agriculture development and climate responsiveness” (CIAT and BFS/USAID, 2016: 1). Since its launch at the 2010 Hague Conference on Food Security, Agriculture and Climate Change, the concept of CSA has gained considerable international currency. It is seen by many as the strategy that will transform agriculture and meet the challenges of development. CSA intends to simultaneously achieve three goals, following the three concept pillars:

1. to sustainably increase productivity and incomes,
2. to adapt and build resilience to climate change from farm to national level, and
3. to mitigate climate change by reducing greenhouse gas emissions or, where possible, by increasing carbon sequestration in agriculture (FAO, 2013; Williams et al., 2015).



### 3.1.2 CSA in the Kenyan smallholder context: climate smart techniques and indicators

How can the content of these three pillars be reached and upheld simultaneously? Bluntly put, food systems “have to become more efficient in resource use: use less land, water and inputs to produce more food sustainably” (FAO, 2013: 8). “Efficiency” here is understood as using fewer inputs and resources to produce the same or a higher number of outputs (*ibid.*). Given the vastness of the CSA concept, it is clear that its application and precise definition depends on the local context and the realities of agricultural production on the ground.

The classic method of increasing productivity, in particular at smallholder farm level, entails the adoption of practices that will allow farmers to reap the full potential of their agricultural lands and their livestock keeping. Smallholders in Sub-Saharan Africa currently operate at approx. 40%–60% of the crop yield potential in their most fertile fields and 10%–20% in poor fields (Tittonell and Giller, 2013). In Kakamega, one of the study areas in Western Kenya, relative maize yields compared to locally attainable levels merely range between 13%–41% (*ibid.*). The promotion of techniques and farm management strategies that help to close the yield gap should therefore be the focus of efforts to increase productivity. Contributing to this goal are the numerous strategies and techniques already in place, such as Conservation Agriculture, integrated soil fertility management, use of improved seeds, intercropping of leguminous crops, or use of leguminous trees in Agroforestry systems, to name but a few.

On closer inspection, these techniques show that the many potential strategies for productivity gains simultaneously increase the farm system's resilience to climate change, with some even producing a net benefit on the farm's overall greenhouse gas (GHG) emissions record. Conservation Agriculture (CA) is one example. CA is a platform technology that consists of three elements: minimum soil disturbance, i.e., no tillage, permanent soil cover through mulching or use of cover crops, and crop rotation. Applied as a whole, the technique contributes positively to all three pillars of CSA (see also Figure 3 below): no tillage means that soil structure is gradually improved, which in turn reduces soil erosion and increases water holding capacities, while permanent soil cover helps to retain more moisture and adds nutrients to the soil. This also increases yield levels and farm resilience to dry spells and droughts. Another advantage of Conservation Agriculture is its contribution to climate change mitigation: no tillage also means that soils release lower amounts of carbon into the atmosphere, thus increasing carbon storage in the ground. At the same time, enhanced soil structure helps to reduce nitrogen loss, which again adds to the positive impact on reduced GHG emissions from agriculture.

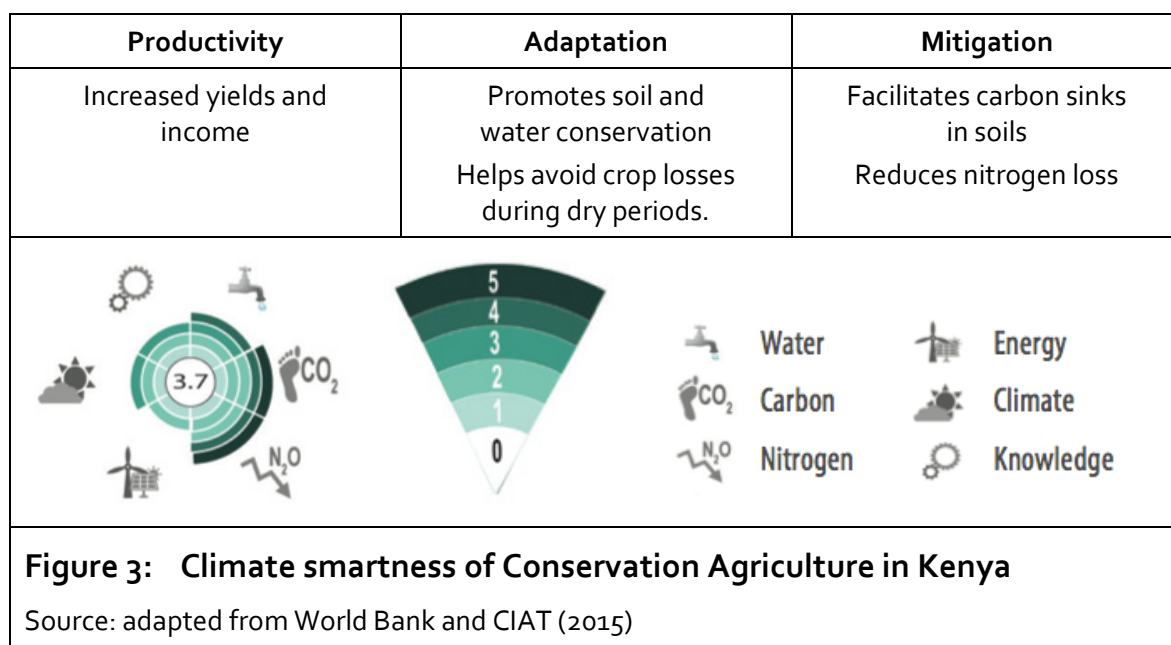
Similar to other techniques, CA uses several methods and practices, e.g., the use of herbicides or increased manual labour for weeding. Here it can be argued that the technique will be "smarter" in terms of GHG emissions and sustainability if the use of chemicals is confined to a minimum. On the other hand, given that manual weeding is labour intensive, fewer farmers may be willing to adopt the technique from the start. There is no straightforward solution to this rather ideological battle, and many farmers and/or NGOs working in this area are likely to have their own ideas on the best method of applying a certain technique to achieve a positive overall impact on farming and climate change.

In the interest of identifying various techniques and comparing them in terms of climate smartness, stakeholders such as the World Bank in cooperation with CIAT have begun to develop technical indicators (World Bank and CIAT, 2015). These measure the technological potential of the different agricultural practices for their ability to contribute to increased productivity, adaptation and mitigation. Given the diverse impacts of such techniques on different backgrounds, the indices are measured and weighted according to national and regional contexts, and may vary considerably from one country to another (*ibid.*). In general, the indicators measure positive changes arising from the implementation of CSA technologies in six categories and are ranked between 1 (low potential) and 5 (high potential) in each category:

## 14 Theoretical framework

- *Water smartness* (improved use efficiency, quality, conservation or capture);
- *Energy smartness* (reduced consumption or increase in use of renewable sources);
- *Carbon smartness* (higher CO<sub>2</sub> capture through increased biomass, increased soil organic matter, reduced soil disturbance or improved livestock management);
- *Nitrogen smartness* (reduced use of synthetic fertilizers, reduced nitrous oxide emissions);
- *Weather smartness* (reduced impacts of climate hazards, climate risk prevention);
- *Knowledge smartness* (rescues and/or validates local knowledge or traditional practices).

These assessments are summed up and averaged across all categories in order to produce a final score per technique. In the overall ranking, the three pillars are weighted equally, but indicators also identify techniques more favourable to one or several of the categories and pillars.



### 3.1.3 Praise and criticism of CSA

Numerous activities have been launched to promote research and implementation of CSA around the globe, establishing it in the post-Paris Agreement era among the prime strategies for agricultural sectors around the globe to meet mitigation and adaptation targets. In 2014, several governments, research organizations, NGOs and private companies came together to form the Global Alliance of Climate Smart Agriculture (GACSA) and to align efforts and coordinate any further action for the promotion of CSA at global level.

Apart from praise, however, the concept has earned a great deal of criticism at grassroots level. In advance of the COP21, for example, a consortium of over 360 national and international organizations and civil society movements issued a joint statement raising concerns about missing definitions and guidelines to accompany the concept of CSA, which would leave the door wide open for environmentally damaging practices and possibly facilitate the “greenwashing” of harmful practices promoted by transnational companies (Actionaid International, 2014). In their fundamental rejection of the concept, most critics consider CSA a highly inadequate means of tackling the challenges of climate change and of agriculture. Instead, they demand a complete transformation of the global food system towards embracing agro-ecology. While the criticism reveals the deep ideological battle between actors in the global food value chain, the concerns highlight the need to come up with clear definitions, guidelines, standards, and safeguards or exclusions that clarify what is regarded as CSA and what is not. This remains a valid point when debating CSA in the context of smallholder farmers, where the concept sows confusion in its demarcation to other agricultural systems promoted in the past. Many development practitioners justifiably raise the question of what is new in CSA.

For the most part, CSA differs from other agricultural development concepts by explicitly addressing climate change, although it also uses techniques and practices covered by Sustainable Land Management (SLM), Sustainable Intensification (SI) and Conservation Agriculture (CA), to name but a few. This is evidenced by definitions of these other systems. SLM, for example, is defined as “the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and ensuring their environmental functions” (WOCAT, 2015). CA generally refers to soil conservation practices in crop production, following clear implementation guidelines as outlined above.

It “aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers” (FAO online). SI, on the other hand, describes a system of “global agriculture in which yields are increased without adverse environmental impact and without the cultivation of more land” (Baulcombe et al., 2009: ix).

Hence the difference between CSA and other agricultural management systems lies in the fact that each of them stresses a different element. While CA and SLM focus on soil protection and management, CSA concentrates on climate change adaptation and mitigation measures, where sustainable soil protection and management are likewise central components (Grainger-Jones, 2011; Neubert, 2016). Numerous techniques that fall under SLM, CA or SI, such as soil conservation structures, use of improved seeds, reduced tillage, or water harvesting and irrigation, are now equally regarded as CSA. It is therefore not surprising that practitioners and policy makers find the exact demarcation between the concepts somewhat fuzzy. Although the three-pillar definition of CSA is intended as clarification of what it means in reality, there is nonetheless a wide disparity and ideological disagreement about how this is actually understood on the ground (Lilliston, 2015; Rosenstock et al., 2016). In general, CSA comprises all farming practices and technologies that simultaneously contribute to at least two of the three pillars (FAO, 2013). For this reason, the concept appropriates elements from existing agricultural management systems that contribute to achieving the three CSA pillars. Further discussion, however, reveals that: “there is no such thing as an agricultural practice that is climate smart per se. Whether or not a particular practice or production system is climate smart depends upon the particular local climatic, biophysical, socio-economic and development context, which determines how far a particular practice or system can deliver on productivity increase, resilience and mitigation benefits.” (Williams et al., 2015: i).

CSA therefore extends beyond the adoption of individual climate smart agricultural technologies at farm level and calls for the simultaneous integration of locally adapted complementary techniques and management strategies that together create synergies and contribute to achieving the three CSA goals. If the achievement of resilience and mitigation effects is to be taken seriously, integrated action at farm and landscape level will be indispensable.

**Box 1: When is a farm climate smart?**

The defining indication that a farm or farm system can be called climate smart is blurry. A universal definition has yet to be developed. In the meanwhile, different actors approach the question differently. In Western Kenya, for example, the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS) in 2011 established so-called climate smart villages, where farm communities enjoyed strong support for the introduction of CSA techniques on their farms (CCAFS, 2016). The farms in these villages are understood to be climate smart once they incorporate improved farming technologies in at least five categories, including soil and water conservation structures, components of agroforestry and perennial crops, diversification of enterprises, improved livestock enterprises, and the readiness of a farm plan for crop rotation management (farmer in Siaya 2016, personal communication). Thus, farmers can choose from different techniques and enterprises and tailor them to their needs and preferences. The concept of climate smart farming guides the analysis in this study.

## **3.2 Innovation diffusion**

This second chapter on the theoretical framework addresses the concept of innovation diffusion, its theoretical background and its relevance in the agricultural sector, notably with reference to the adoption of climate smart techniques. In addition, it introduces the extension service in Kenya as a region-specific framework of major importance in this context.

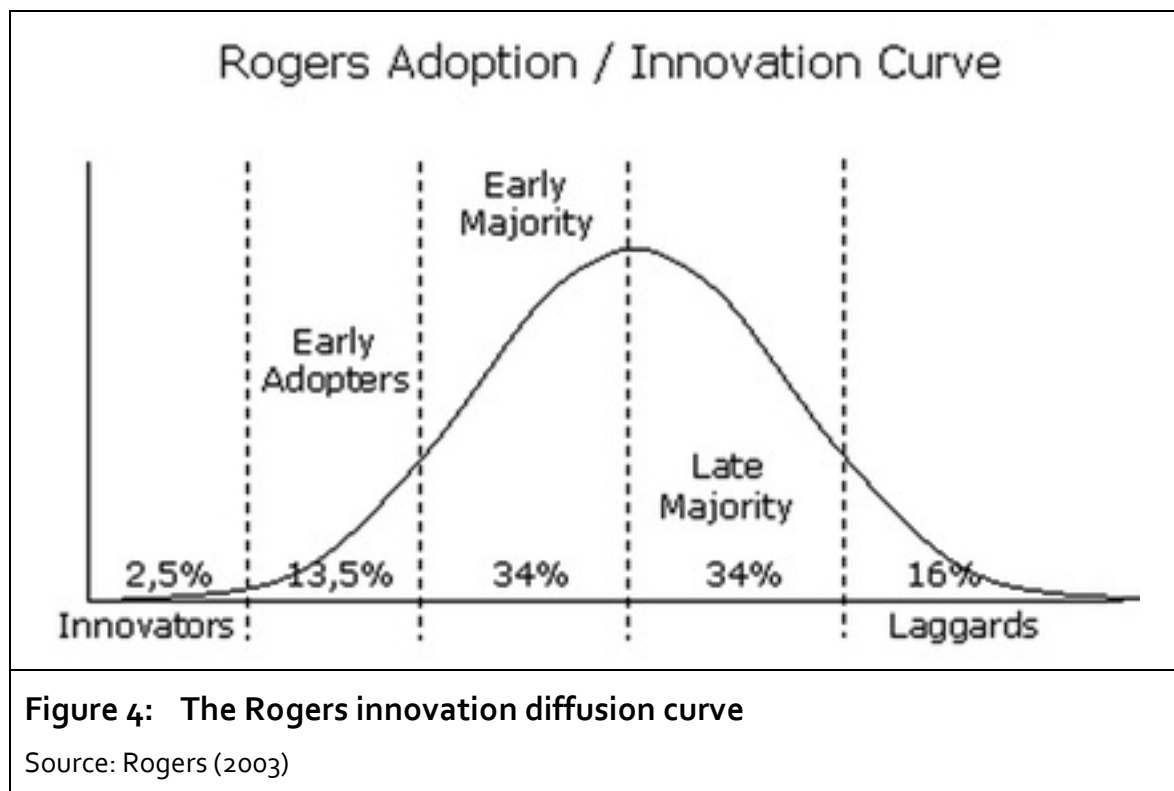
### **3.2.1 Innovation diffusion – theoretical background**

It has been shown that smallholders are particularly vulnerable to climate change. In many areas around the globe, they have already experienced the impact of climate change and recognize the need to respond. Despite a willingness to adopt new technologies, the rate of uptake is usually moderate. Farmers still suffer from yield losses and persistent food insecurity. The adoption of new techniques or practices is not solely a question of the willingness of farmers.

The theory behind the uptake of innovative approaches has been investigated by several authors, first and foremost by Everett M. Rogers, and is known as the concept of “innovation diffusion”. Diffusion in this context is understood as the

process of communicating an innovation to various parties in a social system. An innovation is understood as an “idea perceived as new by an individual” (Rogers, 2003).

The four main elements in the diffusion of new ideas are (i) the innovation, (ii) communication channels, (iii) time and (iv), the context or social system. Rogers illustrated the different speed of adoption by different parties or participants in an innovation adoption curve (ibid.).



Innovativeness describes the “degree to which an individual or other units of adoption is relatively earlier in adopting new ideas than other members of a system” (Rogers, 2003: 12). Diffusion of innovation usually starts slowly and only few people can be convinced in the beginning. It is based on the adopter’s individual needs and characteristics, such as location, media and neighbors.

There are five stages in the adoption process:





Firstly, the person must be made aware of the innovation and gain an impression of how it functions. In a second step, the person develops an attitude toward the innovation. This can either be favourable or unfavourable. The next step is a decision: will the person adopt or reject the innovation? In a final step the innovation is put to use and in time the results are evaluated.

This model can also be applied to the implementation of climate smart agriculture. When outscaling newer concepts such as CSA – or climate smart practices – it is useful to keep track of the different preferences and time constraints.

Bearing this information in mind, the adoption of climate smart techniques or other innovations is clearly not an easy task. The so-called “innovation system” or “network perspective” provides the analytical framework for the study of technological change in agriculture as a process of actions and interactions between different actors in the generation, exchange and use of knowledge (Hermans et al., 2013). Three network functions can be identified:

1. Learning and knowledge co-creation
2. Upscaling and social entrepreneurship
3. Outscaling and innovation brokerage

The network of an actor or stakeholder is an important factor when it comes to the success or failure of adopting a technology or innovation. There is a strong link between the number of adopters in a person’s network and this person’s own willingness to adopt a particular innovation. One issue associated with innovation, however, is unpredictability. An innovation can threaten the status quo of an individual, who may frequently reject the innovation if they have a lot to lose (ibid.).

There is an obvious distinction between gaining the support of an actor in the system’s upper echelons (upscaling) and the horizontal process of knowledge transfer, e.g., between organizations (outscaling). Both are vital to increasing the adoption rate of climate smart techniques at farm level.

### **3.2.2 Adoption: constraints to efficient uptake of CSA innovations**

The topic of innovation adoption is interlinked with risk assessment or risk management. The uptake of a technology depends heavily on the social and economic status of the individual concerned. Social and economic constraints are one of the biggest challenges when it comes to the low diffusion levels of modern agricultural technologies (FANPRAN, 2014). Lack of financial inputs, lack of awareness and an increase in land division into uneconomic units are some examples.

Given that awareness of new or innovative practices is a key factor, the lack of awareness calls for proactive strategies to increase adaptive capacities. In Kenya, and indeed in many other countries, the extension service plays a major role in the spread of technical information among farmers. Worldwide, there are more than half a billion extension officers, over 90% of whom are located in developing countries (Anderson, 2007).

### **Extension service**

The extension service facilitates the adoption of new technologies and the adaptation of innovations to local conditions. In other words, the extension service “tailors” technologies to local needs and farming circumstances. It can enhance human capital by providing inputs such as training and fuel the knowledge flow by multiplying information.

The extension service plays a crucial role in the dissemination of knowledge, technologies and agricultural information and the linkage of farmers to other actors in the economy (Government of Kenya, 2010a). The training of farmers and the adoption of new practices or techniques is mostly in the hands of extension experts. The overall goal of the extension service is to enhance food security through support for subsistence farmers in their transition to a more commercial orientation (*ibid.*).

Agricultural extension in Kenya dates back to the early nineteenth century and the performance of the system has been challenged ever since (Gautam, 1999). There are several extension service systems: train and visit, decentralization, fee-for-service and privatized extension, and farmer field schools (Anderson and Feder, 2007).

The predominant extension service in Kenya works with a demand-supply-relationship of farmers to extension officers. Prior to this demand-driven system, extension was organized differently. The train and visit system was introduced by the World Bank in 1982 as a response to the current “system’s lack of farmers’ empowerment” (Gautam, 1999). Back then, extension was based on a top-down supply-driven approach. The idea was to establish an extension service whereby well-informed extension workers would visit farmers frequently and provide regular technical messages. Contrary to the unidirectional knowledge flow, they were to bring farming problems to the attention of researchers. Many years have passed and the system still faces criticism. The supply-driven system was replaced by a demand-driven system, where farmers contact their respective extension officer should they have questions or need assistance. The perceived suffering

from/under devolution underlines the dissatisfaction with the demand-driven approach in Western Kenya.

### **Technical background of extension officers in Western Kenya**

There are several ways of becoming an extension officer in Kenya: agricultural colleges are key institutions for the education of agricultural personnel. Potential candidates can choose from courses or programmes that take at least two years. Degree courses range from certificates and diplomas to bachelor degrees. Possible fields of specialization are horticulture, animal health and farm management or animal production. Acceptance is followed by an orientation week at the ministry.

Agricultural Training Centres (ATCs) play a major role here. Extension workers at ATCs are not deployed by the county government to participate in the demand-driven system of extension service: ATCs usually train their own staff, who visit farmers on site only if necessary and are equipped with numerous training plots and machinery that serve as a hands-on capacity building platform. ATCs also accommodate trainings for other organizations and their trainers. They thus play a superordinate role and function as a meeting point for stakeholders involved in the training and adoption of, e.g., climate smart techniques.



**Figure 5: Agricultural Training Centre Siaya**

Source: SLE team



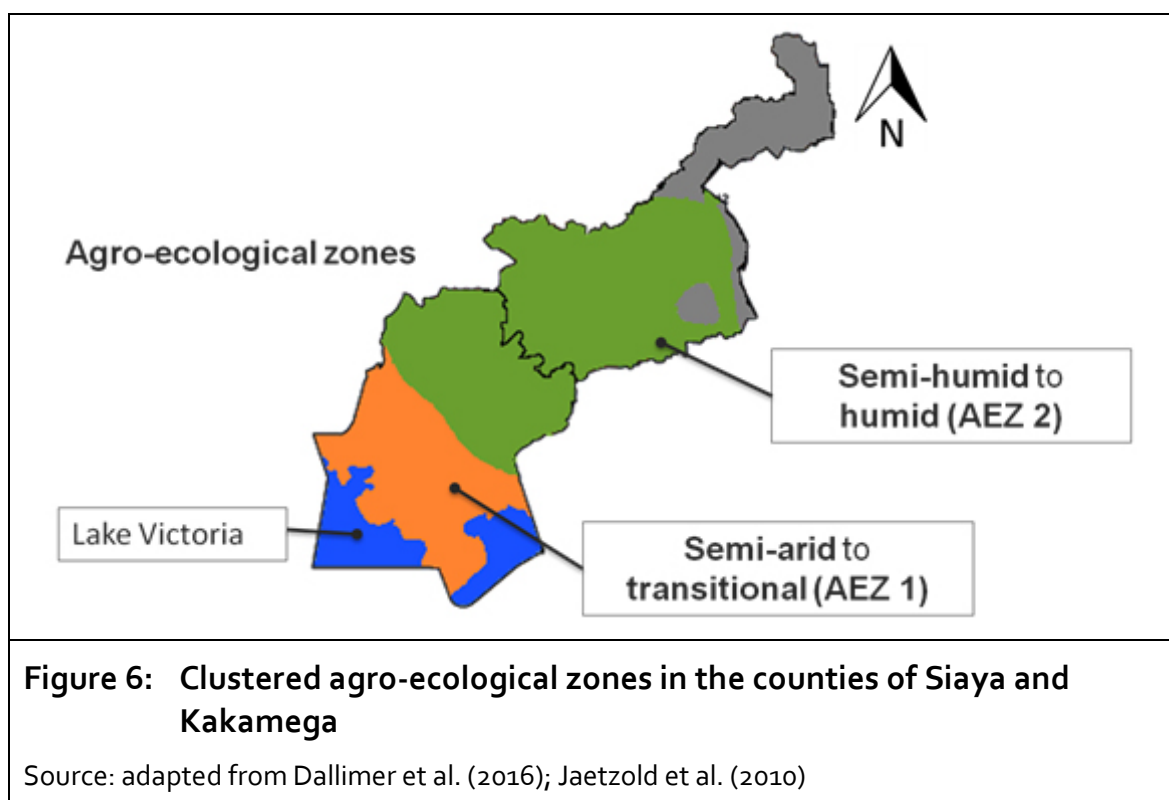
## 4 Methodology

The priority research areas (policy level, farm level and research-extension linkage, see chapter 2) identified for the study cover a wide range of topics for data collection and analysis. Empirical research allows for an explorative and in-depth investigation of the research questions and forms the basis for results relevant to the study. The team designed a mixed-method research approach that includes elements from Participatory Rural Appraisal (PRA), such as focus group discussions, individual interviews and household-level participatory tools from the Evaluating Land Management Options (ELMO) method.

All research results were embedded in the analysis of a policy framework for CSA implementation at county and national level. The aim of the study was to shed light on the concept of CSA, in delimitation to similar approaches such as Sustainable Land Management (SLM), in order to identify overlapping and distinguishing components. Further, there was a need to trace the various regional and global CSA initiatives arising from the current momentum of the concept. To this end, the team conducted an extended literature review prior to the field phase in Siaya and Kakamega. The team reviewed scientific publications and other material, i.e., manuals on the topic of CSA in general and with a focus on (Western) Kenya in particular. The literature review facilitated allocation of the concept into the theoretical framework (see chapter 3). This step also helped to ease the selection of suitable on-the-ground practices that identify as climate smart for the development of technical factsheets.

### Study area

Fieldwork took place in the counties of Siaya and Kakamega in Western Kenya. Most parts of both counties are located at a lower midland altitude range and can be divided into five agro-ecological zones (AEZ). For sampling purposes, the team clustered these AEZs into two major AEZs, a semi-arid to transitional AEZ in Siaya around Lake Victoria (AEZ 1) and a semi-humid to humid AEZ in the direction of Kakamega (AEZ 2). Based on the AEZ description in Jaetzold et al. (2010) and Dallimer et al. (2016), this was adjusted to the research needs and validated by consultation with experts in Kenya. Although the northern parts of Siaya were included in AEZ 2, AEZ1 is subsequently referred to, unless otherwise indicated, as “Siaya” and AEZ 2 as “Kakamega”.



### Survey units

The aim of fieldwork was to explore smallholders' perception of and experience with CSA practices and to identify key bottlenecks and success factors behind the decision for or against the adoption of suitable climate smart techniques. Hence small-scale farmers and extension officers from the two counties became the chief fieldwork survey units. The research also drew from supplementary interviews with experts from politics, academia and local or international advising agencies working on the outscaling of CSA in the area.

### Sampling

The factors that determine the adoption and suitability of CS techniques must be considered within the frame of comparable external conditions. The team therefore selected interviewees from the same AEZ with similar farming systems (i.e., small-scale subsistence, mixed commercial with horticulture, mixed commercial with dairy) via purposive sampling.

As farming systems and consequently the most suitable CS techniques differ in the two counties, one study sample was drawn in Siaya and one in Kakamega. The team selected a number of extension officers and, with their help, farmers for each group. The following criteria were to be fulfilled for 20 farmers:

- male and female small-scale farmers, i.e., those holding eight acres of land or less;
- both subsistence and commercial farmers;
- farmers who had applied selected CSA techniques and those who had not.

For the selection of ten extension officers per AEZ, the team turned for assistance to local counterparts at GIZ Western Kenya. The team also invited relevant experts from policy, academia and local or international advising agencies working on CSA to share their knowledge via interviews.

### Data collection

Before starting the field phase, the team visited the respective county ministries to facilitate further planning. With support from the county, extension officers were identified and invited. They represented the relevant sub-counties of the respective AEZs. The extension officers with whom the SLE team worked in Kakamega and Siaya were between 31 and 57 years old and had working experience varying from five to 37 years. Each one was responsible for several thousand farmers (between 18,000 and 80,000 in Kakamega and between 5,000 and 18,000 in Siaya).

### Methods

The research used a toolkit from qualitative participatory research that was tailored to the survey units, i.e., focus group discussions and various interviews:

#### Box 2: Overview of methods used and number of interviewees/participants

Method	Interviewees
Focus group discussion	(≈) 60
▪ Extension officers	(≈) 20
▪ Farmers	(≈) 40
ELMO (Evaluating Land Management Options)	20
Expert interviews	33

Source: SLE-Team

### A) Focus group discussions

Focus group discussions brought extension officers and/or farmers together and provided an opportunity for intensive data collection and in-depth investigation.

Focus group discussions with extension officers primarily addressed their understanding of the concept of CSA, their expertise in the techniques, and the opportunities and challenges they saw in outscaling practices at both farm and landscape level. Combined with a needs assessment and teaching material requirements, their expertise served as a basis for the design of technical factsheets.

The farmer focus group discussions in Siaya and Kakamega were held in two sub-groups per county, each containing up to ten participants. One of the aims was to address their perception of climate changes (e.g., higher frequency of extreme weather events), to discuss how these impacted on their farms, to learn what strategies they saw for adaptation or had already applied (with related trade-offs and benefits).

### B) Evaluating Land Management Options (ELMO)

Ten farmers per AEZ, i.e., 20 in total, were selected from participants of the farmer focus group discussions and asked to take part in individual in-depth interviews, which mostly involved ELMO and a short questionnaire. ELMO is a participatory tool designed by CIAT to assess farmer perceptions and explanations of the advantages, disadvantages and trade-offs associated with land management choices. In a series of ten steps, this method helps farmers to identify the key characteristics of the different land management or CSA techniques. These include:

- Cost/input requirements
- Benefits/outcomes
- Advantages/positive attributes
- Disadvantages/negative attributes

Each of these features contained a number of components (e.g. cowpeas seeds) and were weighted or ranked against several different CSA techniques in the course of the interview. Farmers were given 20 beans to be distributed freely among the chosen techniques. This establishes the relative rank and weight they would allocate to the techniques previously discussed. Ranking serves to represent the farmers' overall perception of the techniques, notably those they would like to implement on their farms and consider accessible. The individual interviews



and participatory methods addressed male and female farmers of different age, which allowed for identification of gender differences in farming roles, access to inputs and preferred CSA practices. The dialogue helped to gain insights into the suitability and attractiveness of the various CSA practices from the farmers' point of view. The objective was to identify the most suitable climate smart techniques and to establish what farmers need for technology adoption (see also: <https://wle.cgiar.org/evaluating-land-management-options-elmo>).

### C) Individual interviews

Individual interviews contributed to the data for all three research areas. At farm level, in addition to collecting data on general farm management, the interviews served to supply data on the cost of the various CSA techniques. Another goal was to discuss the farmers' experience with the extension service and identify entry points that would facilitate knowledge exchange between both groups. To complete the picture, more than ten experts were asked to take part in expert interviews, either in a personal meeting or via phone/Internet (see Annex 4). They were asked for their opinions and their insights into the success factors and bottlenecks in the case of CSA implementation, the possibilities of outscaling the concept, including incentives, and its relevance for Western Kenya. The extension officers, as experts and resource persons for the suitability of CS techniques and more in-depth cost requirements, provided knowledge for the design of technical factsheets.

### Data analysis

The mixed-methods approach, including PRA and the ELMO method, was implemented in a four-step process. An intensive literature review covered the first phase. A second phase of orientation and method testing, notably questionnaire testing, was succeeded by an intense period of data collection. Feedback loops and result validation with commissioning parties finalized the process.

The data collected from focus group discussions, the PRA methods and individual interviews took the form of completed questionnaires, notes from interviews and in the case of ELMO and other PRA methods, photo documentation. All of the data was treated as qualitative data.

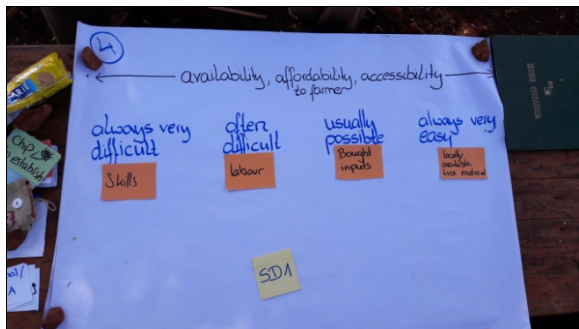


Figure 7: ELMO step 4

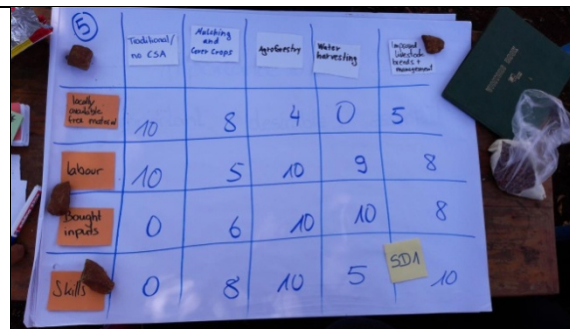


Figure 8: ELMO Step 5

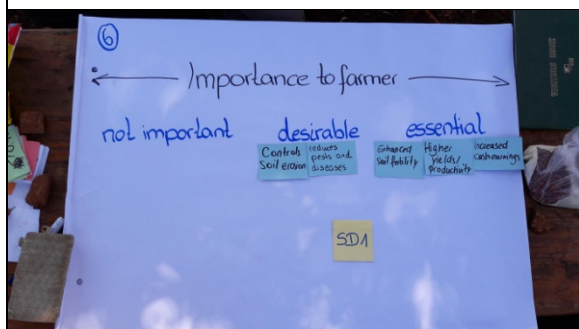


Figure 9: ELMO step 6

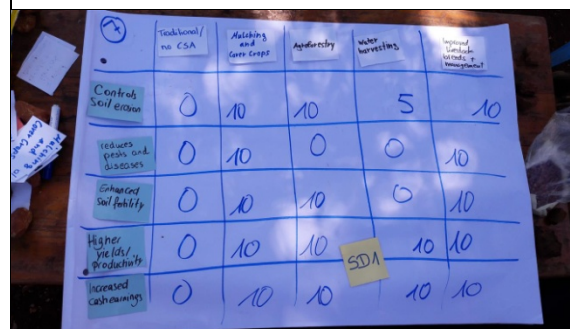


Figure 10: ELMO step 7

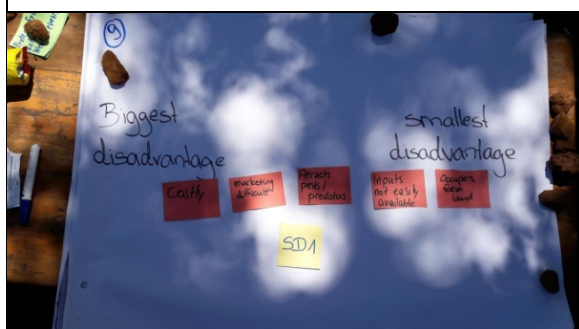


Figure 11: ELMO step 9a

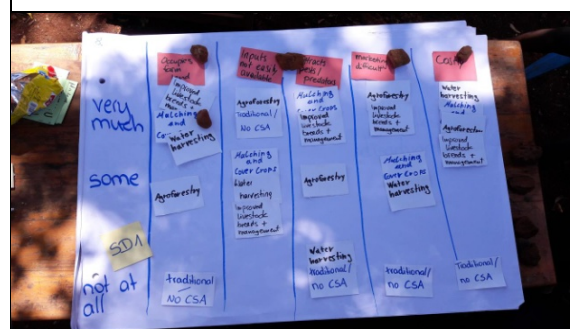


Figure 12: ELMO step 9b



Figure 13: Farmer during ELMO, 1



Figure 14: Farmer during ELMO, 2

Source: SLE team

## 5 Results: CSA in the study region

Having introduced the topic and the methodology, this chapter presents the results of the data collection. Again, results are structured according to the three priority research areas: policy, farm level and research-extension linkage.

### 5.1 Existing policies and prioritization frameworks for CSA implementation

Kenya signed a multitude of treaties within the international frameworks on climate change and agriculture, and is a signatory of all major agreements on climate protection. This chapter gives an overview of the most relevant international agreements. At the same time, it highlights the shortcomings and gaps between national policy and implementation in order to gain more insights into the challenges involved in shaping a climate smart Kenyan agriculture.

#### 5.1.1 International level

Kenya signed and ratified the **Kyoto Protocol**, was among the first nations to sign the **Paris Agreement** of 2015 and submitted its Intended Nationally Determined Contributions (INDC) well ahead of time (UNFCCC, 2016). In this public statement on the country's intended climate actions for the post-2020 era, Kenya explicitly refers to CSA as one strategy to overcome the challenges posed by climate change (Ministry of Environment and Natural Resources, 2015). Kenya is also a signatory to the 2003 Maputo Declaration on Agriculture and Food Security, which means that its government has pledged to allocate 10% of the national budget to agricultural development (NEPAD, 2003). As the main organizational unit in charge of implementing the Maputo Declaration, the Comprehensive Africa Agriculture Development Programme (CAADP) specifies Kenya's strategy for land and water management and targets incorporating CSA into national and local programmes (NEPAD, 2003).

The **Global Alliance for Climate Smart Agriculture (GACSA)** was launched in 2014. The alliance is open to governments from developing and developed countries, NGOs, research institutions, farmer organizations, intergovernmental organizations, and actors from the private sector. As of April 2016, GACSA hosts 120 members and works on three main topics: knowledge, investment, and enabling environment. It targets both large and small-scale farming, and gives the same priority to all three pillars of CSA. The idea behind the alliance was to bundle ef-

forts in the interest of introducing CSA on a global scale. The government of Kenya (GoK) is not a member of GACSA (GACSA online, 2016).

The **Africa CSA Alliance** (ASCAA) was founded in the same year. It is under AU-NEPAD and will be convened through the Comprehensive African Agriculture Development Programme (CAADP). ASCAA distinguishes itself from GACSA by focusing on smallholders and will design and implement its own projects. Its goal is to contribute to AU's "25 by 25" target for CSA. This means that 25 million farm households will have been supported in implementing CSA by 2025. The ASCAA states explicitly that mitigation is of secondary importance compared to food security and resilience. GoK is a member of ASCAA (Africa CSA online, 2016).

### 5.1.2 National level

Climate change is high on the Kenyan national agenda, with the GoK frequently referring to climate change as a major challenge in the future. The fact that various ministries and departments are in the process of developing these strategies and guidelines, shows that Kenya is mainstreaming climate change as a cross-cutting issue and has acknowledged its significance for further policymaking.

At the same time, agriculture is vital to Kenya's economy. It is now widely recognized that transition to a middle-income country will only happen if the key position of agriculture is taken into account in the case of interventions (Government of Kenya, 2014b; Government of Kenya, 2007). On top of this, although agriculture accounts for the majority of Kenya's GHG emissions, it suffers simultaneously from their adverse affects – with projections indicating a more acute situation in the future (World Bank and CIAT, 2015). It is therefore not surprising that Kenya makes a considerable effort to find solutions that will strengthen the role of agriculture in development and at the same time make it more climate friendly.

As Chesterman and Neely (2015) point out, an integrated and promising implementation strategy for CSA in Kenya should be "development smart". In other words, policies and guidelines should not be confined to agricultural challenges but also address issues such as enhanced livelihoods, higher employment rates, and market access.

The findings of Okoti (2015) show that agricultural policies in Kenya focus on food security and poverty alleviation. A national policy specifically aimed at the adoption of climate smart agricultural technologies in the Western Kenyan region is so far lacking. Under the premise of an integrated approach, as demanded by Chesterman and Neely (2015) and others, however, this would not necessarily be a

disadvantage since CSA can and should be tackled with an integrated approach from different perspectives.

The fifth chapter of the **Constitution of Kenya** (Government of Kenya, 2010d) refers to Land and Environment, showcasing the importance of the topic for national legislation. Sustainable Natural Resource Management and the right to food security, for example, are amongst the goals stated in the constitution. It can be assumed to be in line with CSA principles. The amended constitution also contains the principle of devolution with two levels of government, each with distinct roles and responsibilities (ref. chapter 6.1). It therefore gives guidance for the implementation of CSA with respect to a multi-level approach that takes into account the two levels of administration on national and county level.

The goal of the **National Land Policy** (NLP) is to intensify land use in densely populated areas with high agricultural potential using more efficient methods. Among other things it will tackle degradation, soil erosion and pollution (Government of Kenya, 2007). These topics offer potential entry points for CSA. The NLP does not, however, refer to CSA specifically. Both the National Food and Nutrition Policy from 2011 and the Draft National Climate Change Framework Policy from 2014 stress the growing importance of climate change for Kenya's future (Government of Kenya, 2011;2014a).

*The Crops Act* from 2013 establishes sustainable and environment friendly production as the standard for all land cultivation, outlining the role of county governments in implementing national policies and laws, including responsibility for soil and water conservation. One of its main targets is to reduce unnecessary bureaucracy in the crops sector and to enhance cooperation between the relevant entities (Government of Kenya, 2013a).

The *Kenya Vision 2030*, the overarching guideline for flagship projects in the social, economic and political sectors issued by the GoK, illustrates once more that the preliminary goal for agriculture is to increase productivity. It also showcases that Kenya has strong ambitions to enter international markets with its agricultural products (Government of Kenya, 2007).

The *Agricultural Sector Development Strategy* (ASDS) 2010–2020 outlines Kenya's aspirations for the future of the agricultural sector. It stresses the importance of increased productivity and the potential of agriculture to raise a large proportion of Kenya's population out of poverty. This strategy specifies the major challenges to be overcome: low effectiveness of extension services, low absorption of modern technology, and difficulty in accessing the necessary inputs are some examples (Government of Kenya, 2010b).

The *National Climate Change Response Strategy* (NCCRS) refers to adaptation and mitigation in agriculture. Various measures such as the production and promotion of advanced crops species, the promotion of good agricultural practices and insurance schemes are listed (Government of Kenya, 2010c). The Agricultural Sector Development Strategy from 2010 is in turn based on the NCCRS and revolves around sustainable land and natural resource management. The National Climate Change Action Plan is the framework for implementation of the NCCRS. The NCCAP explicitly refers to the vital role of agriculture in climate change adaptation and identifies it as a key sector for interventions (Government of Kenya, 2013b). That said, the term “Climate Smart Agriculture” is not used prominently in these documents. It was obviously not (yet) a priority when these plans and policies were passed. On the other hand, elements of CSA such as conservation agriculture or increased productivity via water harvesting appear throughout the proposed interventions and action plans.

The *Kenya CSA Framework Programme* is the core document that guides current and future implementation of CSA in Kenya. There is a strong focus on the productivity increase pillar of CSA, closely followed by the resilience pillar. The mitigation pillar is clearly subordinate to the other two. The framework document emphasizes that CSA is particularly interesting for Kenya’s future strategies, since it provides opportunities for agricultural growth, the single most important objective of Kenyan agricultural policies. The framework defines concrete outputs in order to reach the stated targets and gives a holistic, extensive view of the entire agricultural sector and its possible ties to CSA. The main point here is enhanced productivity and improved value chains. It underlines the need for enhanced coordination of the relevant actors to improve vertical and horizontal integration (Government of Kenya, 2013b).

Devolution has altered policymaking in Kenya substantially (see below). One of the biggest challenges is coordination between the counties and from county to national level. This is where the Agricultural Sector Development Support Programme (ASDSP) comes in. It is jointly financed by GoK and the Government of Sweden and is located at the Kenyan national level; it has not been devolved. A key activity of the programme is to bolster linkages between stakeholders of certain value chains at all levels and to contribute to policies, strategies and regulations across sectors (Government of Kenya, 2010b). Since the programme focuses on value chains, potentially there are numerous connecting points to CSA, although the topic is not (yet) high on the ASDSP agenda.

It can be concluded from the review of policies and documents that Kenya clearly follows a multi-layered approach to CSA and the associated matters, and does not treat it as an isolated issue. Thus, Kenya follows the approach outlined by Chesterman and Neely (2015) referred to earlier. A multitude of stakeholders, including ministries at both levels, are anxious to bring CSA forward. Waiting in the wings, however, there is a new pitfall here: with so many actors involved, coordination and harmonization quickly becomes the real struggle. Additionally, the policies that address CSA partly overlap, so that responsibilities and mandates tend to be somewhat fuzzy. In this type of setting, lack of coordination is a major challenge. The following chapters will explore these issues, drawing a chronology of devolution and its consequences. Chapter 5.2 considers the county government perspective in order to investigate the reality of these ambitious policies on the ground.

### **Devolution**

Devolution has fundamentally altered the pathways of policy implementation in Kenya. It is therefore crucial to understand these changes in order to design a feasible strategy for the upscaling of CSA.

With the amendment to the constitution in 2010, most of the Kenyan population voted for devolution, which essentially means decentralization. The fundamental idea of devolution is nothing less than to change the relationship between government and citizens, proceeding from a pronounced top-down approach before the amendment to a participatory bottom-up approach thereafter (Kenya School of Government and The World Bank, 2015).

A completely new layer of government was installed in 2013. Legislative and executive power was handed over to the 47 Kenyan counties. Only judicial power remains at the national level (Government of Kenya, 2010d). Apart from the tremendous opportunities of increased participation and representation this process holds, it also posed huge challenges to the newly formed county governments, especially for the agricultural sector as a key component of devolution: responsibilities and functions were transferred to county level more rapidly than initially planned. This left county governments under enormous pressure to fulfil their new roles and deliver results fast. Citizen participation, however, failed to reach the anticipated level. Since devolution is an ongoing process, planning and implementation at county level may still take several years before it is fully standardized and runs smoothly. One of the major challenges of the current phase is harmonization between the counties and coordination with the national level (Kenya School of Government and The World Bank, 2015).

### 5.1.3 County level

The County Integrated Development Plan (CIDP) lies at the heart of all county level activities. Each county issues a plan that is valid for five years, with the opportunity to review and amend it after two and a half years. The counties develop these CIDPs with participation of the relevant stakeholders, i.e., the county government, civil society, the private sector, development partners and the community. For the two counties visited for this report, Kakamega and Siaya, agriculture is a top priority in their CIDP. A number of communication channels are already in place: the governor's conference, a semi-annual summit of all 47 county governors, and the intergovernmental coordination secretariat, which is ministry-specific and sector-specific.

#### *Specific challenges in the study area*

In Kakamega, the County Executive Committee Member for Agriculture (CECM Agriculture) agreed to answer questions on the county's priorities, its day-to-day work under devolution and the cooperation between national and county level. An interview was also conducted with the county director of MoALF in Siaya.

According to the CECM Agriculture in Kakamega and the Country Director of Agriculture (CDA) in Siaya, devolution is still in its infancy. The structure of the agricultural sector is less clear and less concise than it was before devolution began. This has often led to interventions taking place later than planned and lack of project sustainability, which again compromises the impacts in a longer time horizon. Lack of documentation is another issue. Both factors are a stumbling block to efficient implementation.

For Siaya, it was also stressed that political priorities have been skewed to implement as many projects as possible, while capacity development and trainings have not received the necessary attention. If, however, training and capacity development do not take centre stage, the projects will have little bearing on poverty reduction.

Regarding *coordination*, a variety of actors and stakeholders need to be considered and coordinated: With NGOs and international development agencies as major actors in Western Kenya, it is not surprising that they affect the work of the county government, as both interviewees stated. This could, for example, be in the form of much needed funds for county projects, outreach to farmers or technical assistance. On the other hand, the government and NGOs occasionally hamper each other, e.g., by competing for the same workforce.



In terms of *budget*, Kakamega currently spends 9.5% of its overall budget on agriculture, by a fraction falling short of the Maputo declaration goal to spend 10% on agriculture and related research. Nevertheless, the total amount of money available for the agricultural sector is now far less in comparison to pre-devolution times. At times, it was even impossible to send money to the sub-counties. For Siaya, on the other hand, it was stated that lack of absorbing capacity for funds at sub-county level was a major issue.

Examples of prominent topics in the CIDPs for Siaya are irrigation, subsidies and mechanization. For Kakamega, food sustainability, economic agriculture farming (the ability of farmers to sustain food security and earn a monetary income from farming activities alone) and raising the level of quality for agriculture and farming as an occupation are laid down as priorities in the CIDP. Agricultural subsidies from the counties did not exist prior to devolution.

Neither Kakamega nor Siaya use the exact term *Climate Smart Agriculture* in their CIDPs. Siaya, however, has prioritized components of CSA under the term Conservation Agriculture, e.g., water harvesting and irrigation, agroforestry, tree cover, and cover crop. Although the wording may be different, adaptation is key in Siaya politics. In order to get CSA on Siaya's agenda, agriculture must be linked to sustainable food production, e.g., through organic agriculture or minimum tillage, both of which preserve soils for generations to come. In Kakamega, it was also stated that CSA has not yet been implemented at county level but that there is interest in the concept. CSA would have to be linked to existing priorities, however, with increased productivity as the most pressing issue. The CIDP could be amended accordingly; the next plan will be released in 2017. A higher stakeholder demand or interest in the topic could be the way forward to upscaling CSA. CSA could, for example, be implemented through Capacity Development for EOs, but would definitely require cooperation with national level.

#### 5.1.4 CSA stakeholders in Kenya

For an overview of projects, programmes and initiatives that target CSA and its related topics in Kenya, see Table 1. The table shows actors and organizations from research, policy, and implementing agencies working on CSA or related topics, such as Sustainable Land Management, Agroforestry or Conservation Agriculture.

The table also indicates that the projects and actors that are concerned with CSA and similar concepts in (Western) Kenya are many. In recent years, in particular, countless new projects involving CSA have been launched.

**Table 1: CSA-related actors in (Western) Kenya**

(Concepts similar/related to CSA, such as Conservation Agriculture, Agroforestry and Sustainable Land Management have also been taken into account.)

Organization/Actor/	Classification	Main topics related to CSA/ Relevant Projects	Relevant papers/documents/ homepages	Comments
CIAT – International Center for Tropical Agriculture <a href="https://ciat.cgiar.org/">https://ciat.cgiar.org/</a>	Academia, applied research	A range of applied research & outreach activities related to CSA	CSA in Kenya <a href="https://cgspace.cgiar.org/bitstream/handle/10568/69545/CSA%20in%20Kenya.pdf">https://cgspace.cgiar.org/bitstream/handle/10568/69545/CSA%20in%20Kenya.pdf</a>	
FAO MICCA – Mitigation of Climate Change in Agriculture	Pilot CSA programme	A range of CSA Techniques including Adaptation and Mitigation Aspects	<a href="http://www.fao.org/in-action/micca/on-the-ground/africa/kenya/en/">http://www.fao.org/in-action/micca/on-the-ground/africa/kenya/en/</a>	
GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit	Development Cooperation	Projects with a focus on or related to CSA throughout Kenya	<a href="https://www.giz.de/en/worldwide/317.html">https://www.giz.de/en/worldwide/317.html</a>	
ICRAF – World Agroforestry Centre <a href="http://www.cgiar.org/cgiar/research-centers/world-agroforestry-centre/">http://www.cgiar.org/cgiar/research-centers/world-agroforestry-centre/</a>	Academia, applied research, project implementation	Capacity development; agroforestry as an integrated CSA approach	FMNR – Farmer Managed Natural Regeneration <a href="http://fmnrhub.com.au/projects/fmnr-east-africa-kenya/#.V-5sV8lCqVs">http://fmnrhub.com.au/projects/fmnr-east-africa-kenya/#.V-5sV8lCqVs</a>	
N2Africa – Putting nitrogen fixation to work for smallholder farmers in Africa. Led by Wageningen University, affiliations with IITA – International Institute of Tropical Agriculture, ILRI – International Livestock Research Institute. <a href="http://www.n2africa.org/">http://www.n2africa.org/</a>	“research-in-development”	Nitrogen fixation through legumes for smallholders, capacity building, building sustainable partnerships	<a href="http://www.n2africa.org/publications">http://www.n2africa.org/publications</a>	Large-scale research project in 10 African countries, Kenya is one of the so-called “Tier 1 countries”, funded by B&M Gates Foundation

Organization/Actor/	Classification	Main topics related to CSA/ Relevant Projects	Relevant papers/documents/ homepages	Comments
KALRO – Kenya Agricultural & Livestock Research Organization <a href="http://www.kalro.org/">http://www.kalro.org/</a>	Academia, applied research	CSA related techniques (good agricultural practice) for all relevant crops and animals in the national context; screening for climate change tolerant plant and animal species (certified seeds) etc.		KALRO is the most important Kenyan research organization relevant to agriculture
SRI – Sustainable Rural Initiatives <a href="http://www.srikenya.org/">http://www.srikenya.org/</a>	Non-Profit NGO	Fighting rural poverty: Agriculture & Environment, Community Health, Education Support, Skills Development Rainwater collection, tree nursery, Muringa permaculture (all pilot projects)		Focus on WK (Kisumu county). Small, but highly engaged NGO. Numerous volunteers/students.
Vi Agroforestry <a href="http://www.viagroforestry.org/">http://www.viagroforestry.org/</a>	Development Cooperation (Sweden, SIDA)	Fighting poverty and improving the environment, mainly through promotion of agroforestry-systems and tree-planting. Target group: small-holders.	<a href="http://www.viagroforestry.org/projects/kenya/">http://www.viagroforestry.org/projects/kenya/</a>	Active in four African countries. Kenya: Kitale and Kisumu region. Long-standing engagement in Africa (since 1983).
WeAdapt <a href="https://www.weadapt.org/">https://www.weadapt.org/</a>	Bestpractice platform	Economic impacts of climate change in Kenya		
Source: SLE team				

### 5.1.5 Budget for CSA

The CSA Framework Programme lists the following potential budget sources:

- Adaptation Fund
- Green Climate Fund
- Bilateral Development Partners climate finance
- National funding sources
- Private sector leveraging

The programme does not, however, go into detail in terms of actual sums of money required or the most efficient way to spend budgets (Kenya CSA Framework Programme 2015-2030, 2015). There is still clearly a need to budget activities and guarantee sufficient financing.

Currently, the GoK budget support for agriculture does not include financing for CSA implementation. Efforts have been made to create a National Climate Change Fund (NCCF) through the Climate Change Bill as CSA financial support. According to World Bank and CIAT (2015), there is potential in enhancing and promoting Public-Private-Partnerships and upscaling financing mechanisms such as the Green Climate Fund.

On small-scale level, DFID Kenya runs a smallholder CSA programme with an agribusiness finance component that provides repayable grants to selected partners. It is led by micro-finance institutions (MFI) for on-lending to smallholder farmers (Chesterman and Neely, 2015).

## 5.2 The farm level perspective on CSA

A working policy setting and a functioning extension mechanism has the potential to create an enabling environment for CSA outscaling on the ground. This, however, is only one part of the deal. The current chapter will therefore draw attention to the farm level perspective on CSA. The results presented here serve to answer several research questions:

Firstly, the research results allow us to discuss and establish the relevance and specification of the three CSA pillars in the local smallholder context. As will be shown below (ch. 5.2.1), considerations from both policy and farm level in this context highlight the prioritization of productivity and adaptation over mitigation.

Secondly, the results provide insights into farmer perceptions of CSA practices in Western Kenya (ch. 5.2.2). They include a list of locally adapted CSA techniques chosen by the farmers according to the perceived ability of these techniques to make farms more resilient to weather changes and hence increase farm productivity. They also contain an in-depth analysis of perceived costs, benefits, advantages and disadvantages associated with the different techniques. The examined attributes go beyond immediate climate stress relief and highlight factors that constitute barriers and incentives for CSA adoption at farm level, thereby underlining possible entry points for policy recommendations to promote CSA outscaling on the ground.

Certainly, individual farmer perceptions differ greatly and depend entirely on the respective backgrounds and resource endowments. Consequently, apart from delivering a representative picture of the research area and all that that entails, the study also portrays an array of possibilities, perceptions and needs that help to understand, albeit not fully, why farmers adopt or reject certain practices.

### **5.2.1 The three CSA pillars in the Kenyan smallholder context**

CSA was designed as a global concept to combat the challenges of agricultural production and development throughout the global food value chain. The relevance of the three CSA pillars will therefore be different in different contexts. Where agricultural production is primarily characterized by large-scale industrial activity involving heavy investments, large monoculture cultivation or livestock keeping, the intense use of chemicals, and the overuse of natural resources such as land and water, the focus of CSA will be on the role and potential of agriculture in CC mitigation rather than on production increases.

In the Kenyan smallholder context, the potential for mitigation is limited, as is the contribution of agriculture to climate change on the whole. The adoption by small-scale farmers of improved inputs and mechanization is comparatively low, although it bears great potential for increases in productivity and outputs (Government of Kenya, 2010a). Smallholder farmers form the backbone of the Kenyan agricultural sector and the economy rendering them the group most vulnerable to the impacts of climate change (World Bank and CIAT, 2015). Inputs are largely beyond the reach of smallholder financial capacities. This limitation is exacerbated by climate-related events such as droughts and floods, which further hampers production and threatens the food security of the vast rural population (ibid.).

In this context the focus of CSA must therefore lie on increasing productivity and resilience to climate change, with mitigation remaining a subordinate priority for the Kenyan government CSA strategy (Government of Kenya, 2014b). There are, however, attempts to tackle the potential of mitigation even in the smallholder context in Kenya. The National Climate Change Action Plan has identified agroforestry as one of the most promising strategies for CC mitigation in agriculture, with an abatement potential of 4.1 MtCO<sub>2</sub> equiv. by 2030 (Government of Kenya, 2013b). In order to reach this target, the government passed a bill envisioning 10% tree coverage on all farms, including small-scale farms (*ibid.*), which would contribute significantly to reaching this goal. Furthermore, several pilot projects specifically targeting carbon sequestration in smallholder farming are already in place, such as the World Bank Kenya Agricultural Carbon Project (KACP) in Siaya, Western Kenya. Other projects promote Sustainable Agricultural Land Management and carbon sequestration, such as those coordinated by the Swedish NGO Vi Agroforestry (Atela, 2012; Vi Agroforestry, 2016). The mitigation activities in these projects are regarded as potential sources of income for smallholders tapping into funds raised through the Voluntary Carbon Market (*ibid.*, Vi Agroforestry, 2016, personal communication).

At current prices of approx. US\$10 per ton of CO<sub>2</sub>, however, limit the income generated by these projects in the extreme (*ibid.*). In fact, the smallholder potential for carbon sequestration through Agroforestry or Sustainable Agriculture Land Management practices in the smallholder context of Western Kenya remains below 1t CO<sub>2</sub> per acre (Henry et al., 2009), providing income gains in the realm of US\$ 6–8 per farmer per year (Vi Agroforestry, 2016, personal communication). The funds are used to boost community savings and loan schemes, which in turn help to create business development opportunities. At times they are used to promote agricultural training services to farmers (*ibid.*). While the projects have been successfully implemented and outscaled to various farming communities in Western Kenya, their logistics, set-up and management remain challenging. The process involves regular monitoring and evaluation of carbon sequestration, which in itself is costly, and a well-functioning extension service for farming advice and training. The low financial outputs defy the generation of sufficient farm income and can therefore hardly act as an incentive for the adoption of enhanced farming techniques.

Nevertheless, farmers recognize the co-benefits of farm productivity and climate resilience that emerge from implementing the techniques. They constitute the main drivers behind their decisions to adopt the various technologies on their farms (*ibid.*). During focus group discussions, farmers showed little concern for

mitigation, preferring climate smart technologies solely based on their perceived ability to produce direct farming benefits. In the discussion on the different forms of Conservation Agriculture as an example (with and without – or very little – herbicides as more or less ideal in terms of climate mitigation), several farmers expressed concern that a general reduction in the use of chemical aids in farming would increase the risk of food insecurity. It was feared that simple manual weeding or the use of natural pest control would fail to produce the desired results. Although most farmers understood and appreciated the idea of “protecting the environment” and “leaving the environment as nature created it”, they were unanimously concerned about achieving food security and would measure any mitigation effort against its ability to do so.

Against this background, the strategy designed in this study for outscaling CSA among smallholder farms in Western Kenya also focuses on practices that primarily target the productivity and adaptation pillars. Techniques and practices identified as locally adapted and suitable CSA strategies will therefore consider and discuss mitigation only as potential co-benefits arising from the implementation of improved farming practices.

### **5.2.2 Farmer perceptions of climate smart techniques**

#### **Weather changes and impacts**

To establish farmer perceptions of climate smart techniques, participants of the farmer focus groups were first asked whether they had noticed any changes in weather patterns over the last ten or more years that affected their farm activities. This served to identify and subsequently discuss suitable climate smart techniques that would allow them to climate-proof their farms.

The changes mentioned include:

- altered rainfall patterns, with rainy seasons shorter, starting later and stopping earlier, stronger, more unpredictable or extremely low precipitation levels;
- higher occurrence of dryspells or droughts and drying out of streams and rivers;
- higher frequency of floods, especially when rains arrived late and were much stronger than usual;
- higher temperatures, notably with higher extremes of temperature difference within one day;

## 4.2 Results: CSA in the study region

- strong winds, occasionally blowing from unexpected directions; higher frequency of hailstorms.

Subsequent discussions highlighted that strong changes in rainfall patterns were perceived as the most significant impact on farm production. Higher temperatures and heavy sunshine ranked among the top three weather changes, while one group in Kakamega and one in Siaya placed strong winds in third position.

Among the impacts, droughts or longer dry-spells were mentioned by several farmers as being their greatest challenge, but seemed more pressing in the drier areas of Siaya than in sub-humid Kakamega. The farmers explained that it led to uncertainty about when to start planting, while several reported crop losses due to misinterpreting a short early rain followed by a return of long dry periods. Overall, they agreed that the growing season had shifted, suggesting that existing seasonal calendars with information and recommendations on planting activities would need to be reviewed and updated (for further information, see also seasonal calendar in the Annex). As one farmer stated, "When I was young, my father always used to plant exactly in February, as rains used to come during February. But now, the first rain comes in mid-March." (Focus Group Discussion Kakamega, 2016). He went on to explain that the rains not only came late, but often ceased a month earlier, depriving crops of water during the ripening stage, causing crop wilting and significantly reduced yields. When the rains came, they were often short and intense, increasing the risk of floods and soil erosion, as well as water logging, which in turn have an adverse effect on production, notably in horticulture.

Late rains in combination with high temperatures reportedly had adverse effects on soil quality and structure, building crusts and hardpans, while too much heat had a negative impact on soil fauna. Strong sunshine was also mentioned as a factor that curtailed the working hours of farmers in the fields, depriving them of productive time when temperatures became unbearable during the day. Several farmers mentioned negative effects on livestock, as they suffered from high temperatures and droughts and struggled for enough fodder to remain productive, or even died. This was exacerbated by the occurrence of new pests and diseases, affecting both crops and livestock. Farmers also reported higher pest infestation, e.g., ants and termites attacking plants and the tsetse fly carrying disease to their cattle. Several farmers mentioned that delays in rainfall increased the occurrence of *striga* weeds in maize fields, harming plant health considerably and lowering yield levels of the staple crop.



Stronger winds and hailstorms were also mentioned as problematic, but were said to be less severe than the damage caused by rainfall and temperature changes. Winds and hailstorms sometimes led to crop logging and could destroy the harvest of an entire season by severely damaging crops or vegetable gardens. One farmer reported that the trees and shrubs he had planted as wind breaks in recent years were obsolete once strong winds came abruptly from the opposite direction. During farm visits, one of the few farmers who owned a greenhouse stated that the last storm had destroyed it completely.

Overall, group participants stated that unpredictable rainfall, high temperatures and the impact of winds and hailstorms increased the cost of production, since efficiency suffered when the work became more difficult and required more inputs, e.g., purchased fertilizer or pesticides. Growing food insecurity and rising poverty were concerns shared by all focus group participants, and they were eager to discuss and share strategies and practices to respond to these challenges.

### **Locally adapted CSA techniques**

In the process of identifying suitable CSA techniques adapted to local needs, the primary focus was on-farm adaptation, thereby neglecting strategies related to other possibilities such as income diversification via off-farm activities, or migration.

On the whole, the measures discussed ranged from hands-on techniques (e.g., conservation agriculture or water harvesting) to more generic ideas and coping strategies (e.g., enhanced crop management or enterprise diversification). The idea was to be as specific as possible with regard to identifying technologies. Eventually the focus groups came up with two lists of locally preferred technologies, one for each of the two agro-ecological zones (AEZs) (see Table 2 below). The lists later served as a basis for the ELMO exercise, where the choice of techniques was further narrowed down and some of the costs, benefits, advantages and disadvantages per technique were discussed in more detail during individual farm visits. It is important to point out that not all of the listed technologies and associated benefits were mentioned by all of the farmers. Rather, the list represents a compilation of the information gathered during the four farmer focus group discussions and does not include any ranking of the technologies concerned.

In total, the farmers selected 13 technologies, nine of which were chosen in both counties/AEZs, while the remaining four constitute technologies that were chosen either in Kakamega or in Siaya. The identified climate smart techniques are presented in Table 2.

**Table 2: List of locally preferred CSA techniques, uses and benefits**

Techniques	County	When to use*	Benefits
Agroforestry	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods; strong wind; hailstorms; high temperature	Prevents soil erosion, increases soil fertility, creates wind breaks, protects crops from heavy rain and hailstorms, provides shading from sunlight and heat, allows to keep bees to produce honey, tree leaves create beneficial mulch, provide fodder for livestock, attracts rainfall
Certified seeds (drought tolerant varieties)	Kakamega, Siaya	Little or late rain/dry-spells	Early maturing, high rate of germination, bring yields and fodder even during persisting dry-spells, improve food security, tolerant to pests and diseases
Compost, use of manure	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods; high temperature	Brings nutrients and microorganisms to the soil, makes crops look healthier and tolerant, retains soil moisture, makes food produce free from chemicals, reduces need for bought fertilizers, improves soil fertility and crop yields, increases income from selling surplus
Conservation Agriculture	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods; strong wind; hailstorms; high temperature	Improves soil fertility and yields, soil remains in its natural state, makes work easier, reduces labour amount (if used with herbicide), reduces labour costs for ploughing, retains soil moisture during dry-spells, protects soil from heat, reduced logging as plant is growing from deeper holes that increase stability, controls soil erosion
Crop rotation	Kakamega, Siaya		Diversifies and increases income, improves soil fertility and yields, reduces pests and diseases in crops, controls weeds, diversifies nutrition
Improved fodder management (fodder bank, silage)	Siaya	Little or late rain/dry-spells; heavy rain/floods; strong wind; hailstorms; high temperature	Provides fodder during critical times/dry periods, controls soil erosion from wind and water (Napier), improved soil fertility from improved manure quality, cuttings can be sold or used as construction material, provides additional income
Improved livestock breeds and management	Siaya		Improves livestock resilience to local pests and diseases, higher productivity and income, improves nutrition, better quality manure improves soil fertility and increases crop yields, cows represent capital asset

Techniques	County	When to use*	Benefits
Intercropping	Kakamega, Siaya		Improves soil fertility and yields, diversifies income, controls pests, stabilizes main crop plants
Mulching, cover crops	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods; strong wind; hailstorms; high temperature	Conserves soil moisture, protects the soil from high temperatures, brings yields even during persisting dry-spells, reduces labour requirement for weeding, conserves beneficial micro-organisms in the soil, repels pests, prevents soil erosion, produces good humus layer, helps main crops to grow higher
Push-Pull	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods; strong wind; hailstorms; high temperature	Controls pests (stemborer) and weeds (striga), improves fodder availability and dairy production (desmodium, Napier), improves soil fertility and crop yields, desmodium intercrop improves maize plant stability
Soil testing and liming	Kakamega		Provides knowledge about soil, improves soil fertility, improves crop yields
Terracing	Siaya	Heavy rain/floods	Controls soil erosion, improves soil moisture retention, improves yields, maintains soil fertility
Water harvesting	Kakamega, Siaya	Little or late rain/dry-spells; heavy rain/floods	Provides water during dry-spells and droughts, can be used for crop irrigation and livestock, allows production all year round, allows production for niche markets, reduces labour costs from water fetching
<p>* Only filled in if use was specifically indicated during the group discussions; more detailed explanation of individual techniques in Annex 1</p> <p>Source: SLE team</p>			

In line with World Bank CSA indicators, almost all of the techniques chosen by farmers have a medium to medium-high score in climate smartness (see Table 3 below). This can be divided into a mitigation score (considering the impact on carbon, nitrogen and energy) and an adaptation score (considering water, weather and knowledge). According to this ranking, agroforestry, conservation agriculture, intercropping, compost and the use of manure and crop rotation are among the highest ranked climate smart techniques with reference to overall climate smartness. Highest scores in terms of adaptation are allocated to agroforestry, certified drought tolerant seeds, conservation agriculture, intercropping and water harvesting. Mitigation smartness sees the highest scores given to agroforestry, conservation agriculture, compost and use of manure, crop rotation and improved livestock breeds.

Table 3: Climate smartness of selected CSA techniques

CSA practice	Smartness dimensions						Average	Adaptation	Mitigation
	Water	Carbon	Nitrogen	Energy	Weather	Knowledge			
Agroforestry	ND	ND	ND	ND	ND	ND	ND	ND	ND
Certified drought tolerant seeds	3	1	1	3	4	3	2.5	3.3	1.7
Compost, manure	3	3	2	1	2	2	3.2	2.3	3.3
Conservation agriculture	4	5	5	2	3	3	3.7	3.3	4
Crop rotation	3	3	5	2	3	3	3.2	3	3.3
Improved fodder management	3	2	2	1	4	2	2.3	3	1.7
Improved livestock breeds	2	4	5	1	1	2	2.5	1.7	3.3
Intercropping	4	3	5	3	3	4	3.7	3.3	2.7
Mulching, cover crops	2	3	2	3	4	3	2.8	3	2.7
Push-Pull	ND	ND	ND	ND	ND	ND	ND	ND	ND
Soil testing and liming	ND	ND	ND	ND	ND	ND	ND	ND	ND
Terracing	3	2	3	1	3	3	2.5	3	2
Water harvesting	5	2	3	3	3	3	2.9	3.3	1.7

Expected benefits in smartness dimensions: 1 = very low, 5 = very high, ND= No data

Source: adapted from World Bank and CIAT (2014, 2015)

Results of the focus group discussions show that a number of farmers in the region are well aware of the farming challenges arising from weather changes and the potential opportunities associated with the various climate smart techniques. Several farmers remarked that they had already applied some form of weather-adapted techniques on their farms and reported on positive outcomes. Most farmers, for example, practiced forms of intercropping and composting, and many of them used some certified seed varieties. Yet, most farmers also stated that they lacked the financial means, knowledge and technical support to adopt enhanced farming techniques. Of particular interest were techniques beneficial to improving soil water management, such as water harvesting, agroforestry or conservation agriculture, but at the same time thought to be technical and expensive, and consequently difficult to apply.

### **Results of the ELMO tool**

To gain a more detailed impression of the drivers that would influence farmers in their decisions for or against adopting CSA techniques, the SLE team carried out twenty follow-up on-farm interviews with farmers from the focus groups. The Evaluating Land Management Options (ELMO) method, as described in chapter 4, was applied in the interviews. Drawing on participatory research methods allowed the team to explore farmer perceptions of the techniques and their associated benefits and barriers/disadvantages.

Generally speaking, all of the techniques were chosen at least once per study area, indicating the diversity of farmer preferences. Among those most discussed were compost and water harvesting, which interested farmers in Siaya and in Kakamega preferred to a similar degree. Compost was a technique already applied by several farmers in the normal way, while water harvesting was practised almost nowhere. This notwithstanding, the farmers saw it as a highly interesting technology and were keen to learn more. Most of the other techniques varied in their familiarity and perceived usefulness across the two counties. ELMO farmers in Kakamega, for example, were more familiar with and excited about Conservation Agriculture than farmers in Siaya, while the opposite was the case with Agroforestry. Intercropping, while initially chosen as a climate smart practice in the focus groups, was rarely chosen afterwards. One reason for this might be its common application by farmers in the area, so that farmers from the groups were keen to discuss more innovative techniques.

Throughout the ELMO interviews, the farmers were consistent in their desire to implement some form of climate smart management rather than fall back on a

“No CSA” scenario. This is evident from the final scoring of the selected climate smart techniques. While there was no strong preference for one particular technique, the results clearly indicate a unanimous rejection by all farmers of the “No CSA” scenario as highly undesirable (compare Table 4).

<b>Table 4: Ranking of CSA techniques according to farmers’ overall preference</b>		
<b>Rank</b>	<b>Kakamega</b>	<b>Siaya</b>
1	Conservation Agriculture	Compost/manure
2	Agroforestry	Improved livestock breeds & management
3	Compost/manure	Certified seeds (drought tolerant)
4	Certified seeds (drought tolerant)	Conservation Agriculture
5	Soil testing and liming	Crop rotation
6	Water harvesting	Improved fodder management
7	Crop rotation	Water harvesting
8	Push-pull	Mulching and cover crops
9	Intercropping	Push-Pull
10	Improved fodder management	Agroforestry
11	No CSA	Terracing
12	—	No CSA
Source: SLE team		

According to this ranking, compost/manure, improved livestock breeds and management, use of certified drought-tolerant seeds, Conservation Agriculture and crop rotation were among the top five techniques rated in Siaya, while Conservation Agriculture, Agroforestry, compost/manure, certified drought tolerant seeds and soil testing and liming scored as the top five in Kakamega. Given the small sample size, however, the result is not representative for the counties. At the same time, the research gives some idea of the reasons for these preferences, drawing on farmer perceptions of the different techniques and their attributes.

### **Making a farm climate smart**

Creating a climate smart farm obviously calls for more action than to simply pick and apply any one of the above techniques. Since the essence of CSA is integration, farmers should choose and integrate a smart combination of techniques in line with their ability to create synergies between the different productivity, adaptation and mitigation targets. While combinations of climate smart techniques are manifold, the present study suggests adhering to a guideline that sees five overall categories to be met in the design of a climate smart farm. Returning to the concept of the climate smart villages in Nyando, Western Kenya, a farm is considered climate smart if it includes technologies and practices from each of the following categories:

- Soil and water conservation structures (e.g., via water harvesting, terraces, composting, Conservation Agriculture);
- Integration of perennial and annual crops (e.g., via Agroforestry; the farm should never be idle/unproductive);
- Improved livestock enterprises (e.g., improved livestock breeds and fodder management);
- Diversification of enterprises (e.g., through intercropping, crop rotation or inclusion of processing steps further up the food value chain);
- Readiness of a farm plan (to provide scope for better management and planning of future activities, also useful for crop rotation).

The technologies mentioned earlier can be used to flesh out these categories. It should be remarked at this point that numerous other ways of creating synergies with climate smart technologies exist but were *not* chosen by the farmers (e.g., a combination of composting and biogas production). Although several of these techniques might be suitable for the region, the farmers rejected them as too expensive or too complex. This underlines that the list presented above is not exhaustive but can be complemented with further research and training activities.

While a smart combination of techniques is desirable for all of the farmers, it is evident that their investment decisions should be based on techniques, inputs, skills and labour requirements tailored to their individual needs. The following section will therefore continue to examine farmer perceptions of the advantages and disadvantages of the individual techniques.

### **Relative importance of costs, benefits and economic attributes to farmers**

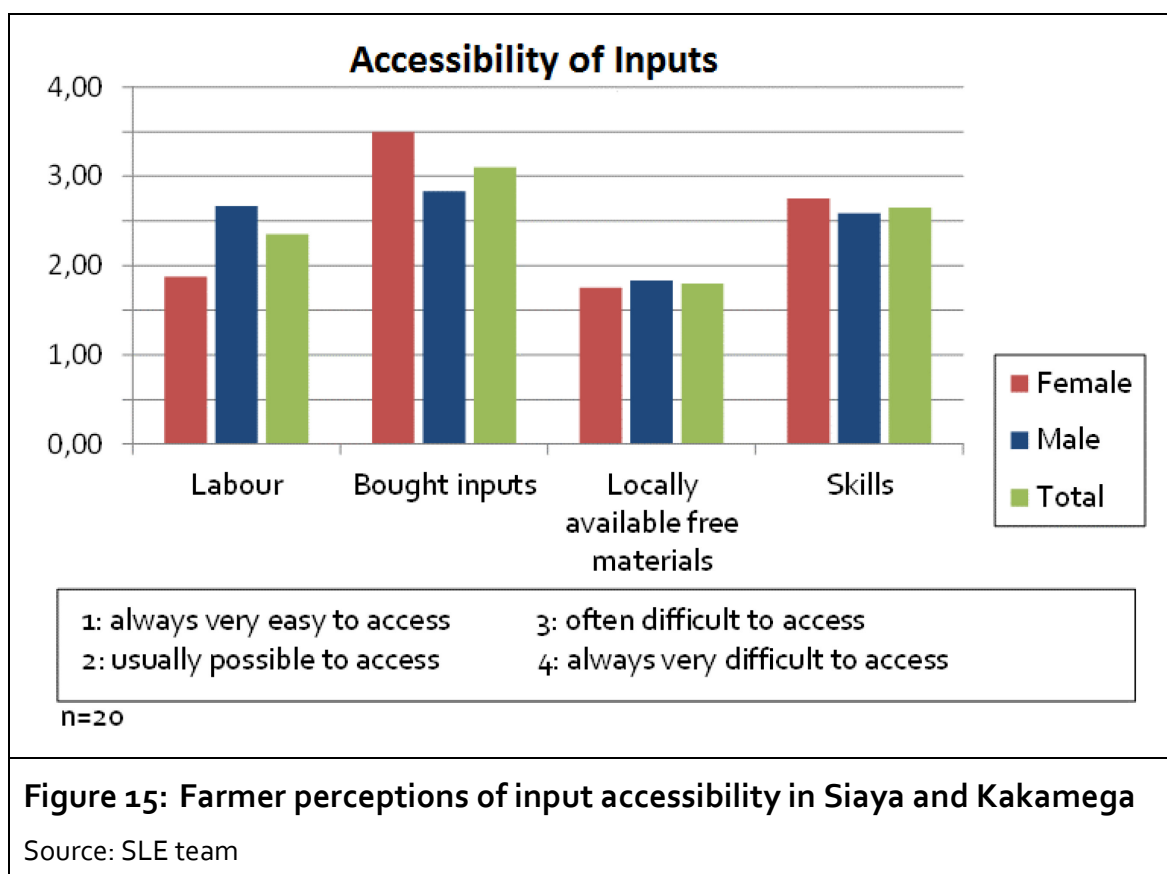
In the context of selecting climate smart techniques, the farmers were asked about their perception of the input costs, benefits, advantages and disadvantages of the various techniques. The results produced a heterogeneous picture in terms of needs, knowledge and skill levels, as well as financial capacities.

When asked what farmers sought to achieve or avoid by implementing different techniques, participants in both study areas highlighted a range of monetary and non-monetary factors they perceived as driving their decisions. Quick returns and improved food security were among the highest priorities of farmers in both Kakamega and Siaya. Similarly, higher yields and productivity and the associated increase in income and cash earnings were perceived to be only slightly less important. At the same time, the majority of farmers stated that most features not immediately related to economic gains, such as greater soil fertility or control of soil erosion, could be transformed into monetary values in a long-term perspective.

The farmers were also asked to name the disadvantages they perceived as the greatest barriers to adopting individual techniques. The (high) cost of establishing a technique was considered less daunting than other disadvantages. In fact, the farmers ranked pest and disease attraction, the time factor involved in reaping benefits, and the unreasonable amount of labour as far greater obstacles to be surmounted. This slightly contradicted the focus group results, which saw lack of finance as the definitive factor preventing technology adoption. Confronted with a detailed breakdown of the associated advantages and disadvantages of each technique, however, the farmers found other factors to be more important when it came to making their technology decisions.

On average, farmers found requirements such as skills, labour and local materials usually accessible, although the required skills were seen by some as difficult to access. Only bought inputs were ranked as a difficult-to-access requirement in farming. Further inquiry revealed that the key difficulty was seen to be input availability in local shops rather than input costs. Improved seeds of drought-tolerant crop varieties, seedlings of agroforestry trees and specific technical equipment such as direct seeders for Conservation Agriculture are some examples. Farmers frequently stated that purchasing these called for travel to distant markets. For the more advanced technologies such as water harvesting, bought inputs refer to equipment in the form of polythene sheets and water tanks. Here, farmers emphasized that apart from local availability, the purchase and transport of input requirements was an equally important barrier.





Looking at female and male farmer perceptions, there is a slight discrepancy between access to labour resources and bought inputs. Women seem to have more difficulty in accessing inputs, but consider labor resources easier to obtain than men do. This confirms previous statements from focus group discussions, where both male and female farmers stated that women generally have greater difficulty when it comes to accessing credits. At the same time, given that men tend to pursue off-farm activities for additional income, more and more women are taking on the responsibility of farm management (Kleemann, Scheurlen and Semrau, 2016).

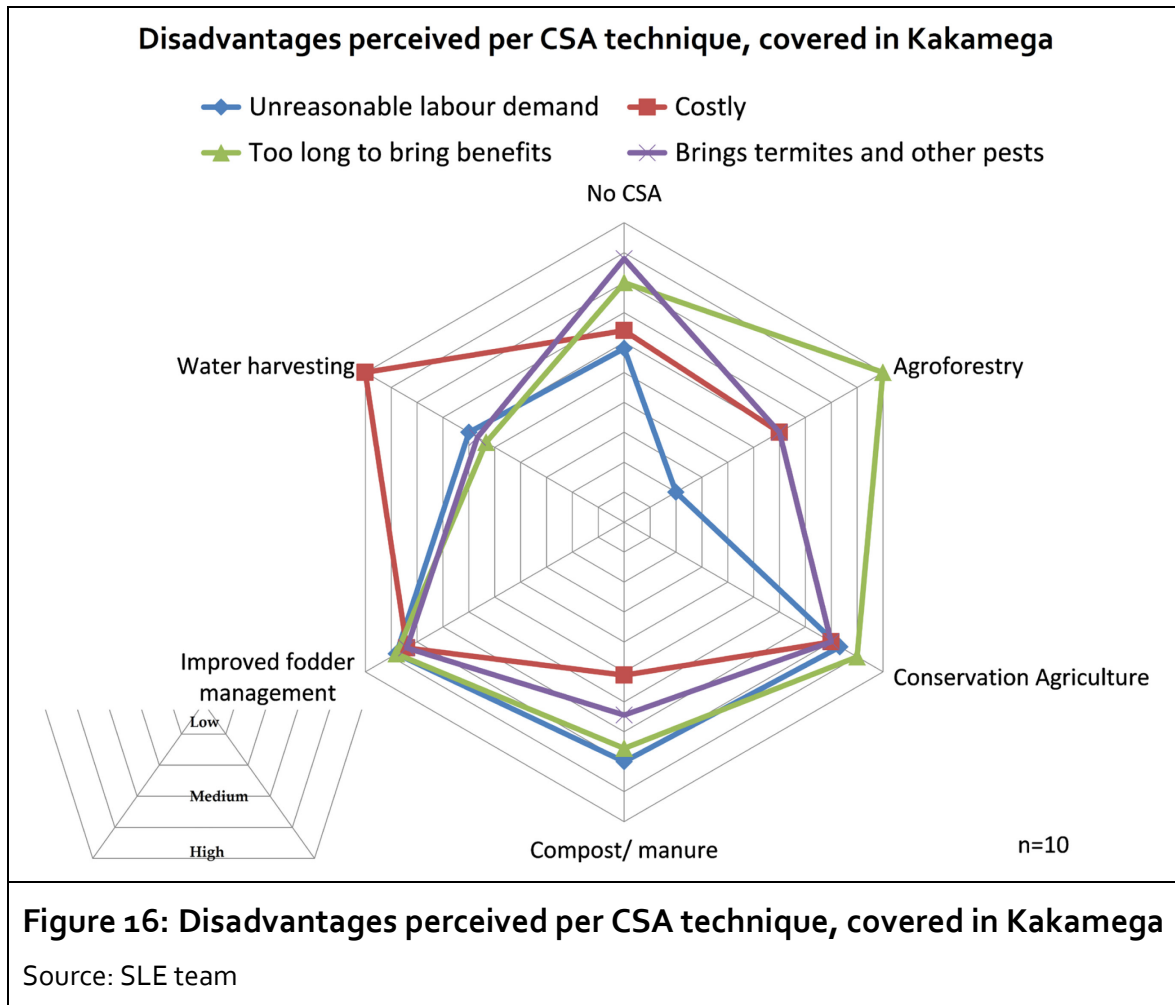
Women also ranked most monetary attributes, such as increased cash earnings, small upfront requirements and the total cost of establishment, less important than men did. On the other hand, women gave greater importance to attributes linked to the environment and farm sustainability, such as increased soil fertility, environment protection, reduction of pests and diseases or control of soil erosion.

### **Adoption barriers related to specific CSA techniques**

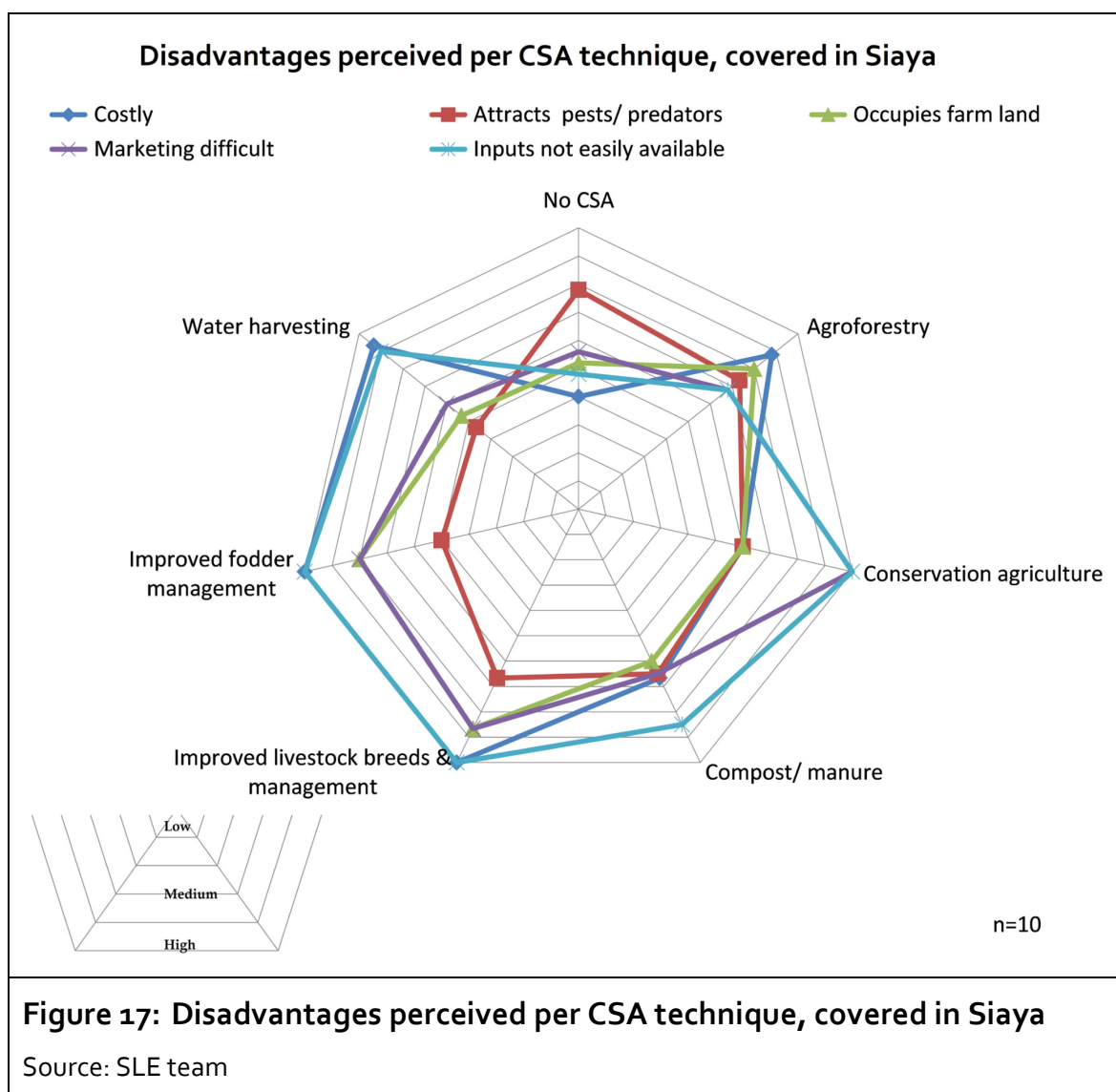
Identifying the benefits and uses of specific climate smart techniques is a first step in the process of promoting climate smart farm management on the ground. Yet, while each CSA practice targets specific climate-related problems and produces an array of benefits, each technique also holds challenges and disadvantages that may influence farmers in their decision and ability to implement the practice on the farm. Taking a closer look at some of the more preferred CSA techniques permits major insights into what farmers perceive as a considerable disadvantage and thus an adoption barrier.

Here, farmers in Kakamega and Siaya identified a range of potential problems and disadvantages associated with specific techniques. In Kakamega, for example, farmers were concerned about high labour requirements, high costs, the time it takes for a technique to produce benefits, and the possibility of a practice attracting termites or other pests (a common side-effect observed, e.g., in mulching with crop residues). It should be noted that all of the preferred techniques were assessed as having at least one strong disadvantage. In agroforestry, for example, farmers were mostly anxious about the timespan before the first harvest and financial returns. Water harvesting, on the other hand, was regarded as expensive. Conservation Agriculture and improved fodder management scored high in all disadvantages, indicating that farmers felt generally unable to cope with the techniques involved. Composting and the use of manure scored medium-high in all categories.

In Siaya, farmers were also concerned about high costs and the possible attraction of pests or predators. In terms of individual techniques, however, these concerns were ranked lower than other disadvantages. Further disadvantages of significance to the farmers were the occupation of farm land otherwise allocated to food crop production, low input availability, and difficult marketability of outputs such as soya beans, which although highly beneficial to soil fertility face low local demand. The results confirm the earlier statement of farmers that input availability was perceived as the key problem in adopting technology, as it was ranked high to very high in almost all selected techniques apart from Agroforestry. Concerns surrounding the attraction of pests or predators, however, were ranked comparatively low, albeit these still scored above medium in all techniques.



At the same time, farmers also ranked disadvantages to be medium to high in the use of compost and manure, although the technique is widely practiced by farmers. This indicates that there are factors other than perceived benefits and costs or disadvantages that influence the farmer's decision for or against technology adoption. External guidance and support from extension officers or government or NGO projects is likely to play a crucial role in this context. An assessment of their impact on specific technology adoption, however, would exceed the scope of this research.



Overall, the research made it possible to identify locally suitable CSA techniques that match on-the-ground realities and challenges faced by local farmers; at the same time, it highlights some of the key barriers to technology adoption as perceived by these farmers, both in general and in connection to specific CSA techniques. A CSA strategy will have to consider these findings and strengthen the success factors, while simultaneously tackling challenges and design approaches to overcome the barriers.

### 5.3 The linkage between scientific agricultural research and practical application at farm level via extension services

A functioning research-extension-implementation linkage consists of good co-operation and communication between the main stakeholders, i.e., research organizations, the extension service and the farmers. Simplified, research passes its results to the extension service, which then translates it into farm-level language, trains farmers in new technologies and informs them of new inputs. Conversely, extension can report farm-level difficulties back to research, where adjusted research is conducted and delivered to the targeted beneficiaries, the farmers.

This study concentrated on the extension service in this linkage and its special role in the outscaling of CSA as a new concept (see also chapter 3.3.).

#### 5.3.1 Relevant actors in Kenya

Relevant actors in the research-extension linkage are farmers, research institutions and extension services. The actor group “farmers” was presented in Chapter 5.2. This sub-chapter focuses on the remaining actors, namely, research organizations and extension services.

##### Research institutions

In Kenya, the main agricultural research institutions are the Kenya Agricultural and Livestock Research Organisation (KALRO) – formerly Kenya Agricultural Research Institute (KARI) –, the Kenya Forestry Research Institute, the Kenya Marine and Fisheries Research Institute, and the Kenya Industrial Research and Development Institute. Additionally, the Kenya Seed Company (KSC), a state corporation, is involved in agricultural research related to seed production (Government of Kenya, 2010a).

Further, universities carry out independent agricultural research. Last but not least, regional and international research institutions, e.g., CIAT, with regional and international mandates offer opportunities for the enhancement and completion of the Kenyan agricultural research agenda (Government of Kenya, 2010a).

KALRO is the most important Kenyan research organization relevant to agriculture. It focuses on the linkage between research and extension services rather than on the direct translation of results into farm-level language. The procedure for the identification of research topics adheres to the following scheme:

- Farmer challenges are identified
- Research concepts are designed
- Research concepts are presented to a multi-stakeholder committee

Results reach regional extension officers via capacity building and the Ministries of Agriculture, and are archived in KALRO's own web-based database and its library (KALRO, 2016, personal communication).

CIAT as an independent international research organization translates its academic information to the practical level via the “proof of concept to implementation” approach, beginning with trials in various locations followed by field demonstrations and concluding with scaling-up strategies (CIAT, 2016, personal communication).

Today, CSA takes centre stage in research. Results are published and discussed. But somehow, the concentration of knowledge is limited to academia.

### **Extension services**

Extension officers (EOs) work towards enhancing food security by helping farmers at all stages, notably ensuring the correct execution of steps to adopt a particular, e.g. climate smart technique. Extension officers<sup>1</sup> help farmers to make the right choice of practices and support their implementation and subsequent maintenance.

Today, most extension officers are county government employees. Other extension agents are the staff of NGOs or private companies, such as seed firms.

There are two ways of running an extension service. One is the demand-driven approach. Farmers have the option of contacting their extension officer via various means of communication, e.g., mobile phones or personal visits. The second approach is affiliated to projects of the respective county. In this case, the county facilitates the extension officer to go into the field and promote the projects of different actors.

### **5.3.2 Post-devolution structures and coordination processes of the extension service**

The structure of the extension service in Kenya did not change after devolution. Its management did. Today, the linkage between research, extension and

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<sup>1</sup> The different paths to becoming an extension officer have been explained in chapter 3.3.

farmer is coordinated and organized via periodic stakeholder forums, which are held less frequently, however, than in pre-devolution times or no longer exist (CIAT, personal communication). The stakeholder forums were once divided along thematic lines, such as horticulture, livestock or agribusiness. Information filtered down from the national to the provincial level and from the provincial to the district level (GIZ, personal communication). This information flow is now interrupted. There is still a high concentration of knowledge at the headquarters but it no longer trickles down efficiently and rarely reaches the lower echelons. Intergovernmental working groups are responsible for coordination of the EOs in the counties. Coordination meetings take place only twice a year due to financial constraints and participation of EOs is dependent on the available funding (extension officer from Siaya, personal communication). CSA is a complex concept that is currently gaining momentum in research and being discussed at national level, although in Kenya, the news has not yet reached county level (GIZ, personal communication).

Following devolution, all responsibilities for the extension service lie with the county ministries. As an exception, the capacity development of extension officers lies in the hands of the National Ministry of Agriculture, Livestock and Fisheries in order to guarantee similar standards throughout the country (County Government Kakamega, personal communication). The findings of research organizations like KALRO or CIAT, however, fail to find an echo in training curricula (CIAT and KALRO, personal communication).

### 5.3.3 The research-extension linkage

KALRO and CIAT representatives were asked to give an evaluation from the research perspective and to share with the team their perception of the current research-extension linkage in Siaya and Kakamega.

KALRO organizes the linkage between research institutions and the extension staff in Kakamega via an “extension link person”. Research findings, including new crop varieties and techniques, are filed in KALRO’s database and accessible for extension. KALRO also offers to lecture and train at workshops and is available for specific information on request (KALRO, 2016, personal communication).

Representatives of KALRO still see the exchange between research and extension as “good cooperation”, since KALRO cooperated with the extension services and the respective ministries on a regional basis prior to the devolution process.

Strong cooperation exists between KALRO and CIAT, and between CIAT and the national universities. CIAT research results only reach the ministries and extension officers through joint field activities and the somewhat infrequent stakeholder forums. This was not the case prior to devolution (CIAT, 2016, personal communication). Instead, CIAT multiplied its findings through public-private partnerships that focused on government and non-government extension officers (ibid.).

### **Extension from a practitioner point of view**

The personal background of the extension officers with whom the SLE team worked in Siaya and Kakamega displayed high variations in age, work experience and the number of farmers under their responsibility. The sub-counties in Kakamega showed discrepancies in the frequency of participation in EO trainings. Almost all extension officers are contacted by small-scale farmers on a daily basis via mobile phones or personal visits.

The extension officers interviewed in Kakamega were not satisfied with their current working conditions and saw difficulties in the outscaling and broad adoption of complex, i.e., climate smart, techniques. Apart from financial constraints, the staff pleaded for more farmer support. It was underlined that a knowledge exchange flow between research, extension officers and farmers was essential.

In contrast to other actors, extension officers see a substantial difference and deterioration in comparison to their work before the devolution process. Extension officers were used to having their own budget; fuel, mobility and even demonstration material was provided. Apart from monetary constraints, devolution seems to have caused a state of confusion in most actors. Extension officers criticize the ambiguity of responsibilities and roles of higher officers and the unclear communication between hierarchies. In the past, the national government supported them with technical manuals, for example, whereas nowadays extension officers feel left alone in the jungle of information material and with decisions such as what to use and how much time to spend looking for suitable material, pointing out that ultimately it is the farmers who will suffer. Depending on the material the extension officer uses, information will differ and ultimately confuse the farmers, who have no idea what information is correct. Extension officers expressed the desire to have concise information material on climate smart agriculture and its practices for their respective counties.



## 6 Discussion of results

The study was carried out to identify entry points that would serve as a basis for a strategy design to outscale locally adapted climate smart agriculture among smallholders in Western Kenya. The last chapter highlights the findings of the three priority research areas:

- At *policy level*, the status quo on policy prioritization of CSA was assessed throughout Kenyan international, national and county level politics. Entry points for improved CSA mainstreaming in the policy and institutional environment at county level were identified in Kakamega and Siaya, also with reference to the accessing and allocating of funds to provide financial assistance for farmers and practitioners in the area.
- At *farm level*, a list of locally suitable and preferred CSA techniques was drawn up to address some of the challenges reported by the farmers. Discussions focused specifically on the farmers' perception of these techniques and highlighted key areas that call for further support to promote technology adoption. The relevance of the three CSA pillars in the context of local smallholder farmers was also discussed.
- At the *research-extension-implementation level*, the structure and management of the government extension service was assessed against its potential to play a key role in the distribution of knowledge and information on the ground and thus act as a catalyst for the outscaling of CSA. Here, information dissemination channels between the different hierarchies were considered, including those between research/academia and technical practitioners, on the one hand, and between practitioners and farmers, on the other.

A successful strategy to outscale CSA must act simultaneously in the identified areas and create a favourable framework that will permit farmers to adopt enhanced farm management plans.

Reaping the full benefit of the strategy demands certain knowledge and a systematic approach. For this reason, numerous CSA techniques are seen as a skill intensive approach that includes training and capacity development. Farmers must learn to understand the needs and objectives of their own production systems in order to minimize trade-offs and maximize benefits.

The following section discusses the findings presented above, highlighting entry points for recommendations and potential shortcomings.

## 6.1 Policy level

A crucial finding at policy level was the absence of CSA in the County Integrated Development Plans (CIDPs) of both counties. The enormous interest of county-level policy makers in this topic, however, gives cause for hope that CSA will be adopted and implemented in Western Kenya. As with any development strategy, political will and beneficiary ownership is crucial to achieving the defined goals. In the context of Western Kenya, policymakers and technical experts were obviously keen to implement and promote CSA. Yet, current priorities at county level seem to concentrate on finalizing and stabilizing governing structures and processes of devolution. A functioning policy apparatus is also a precondition for the successful creation of an enabling policy and institutional framework for CSA outscaling.

As emerged during research, the biggest challenge here seems to be coordination of the relevant stakeholders. Feedback from both counties on this issue suggests that numerous improvements are necessary. Following devolution, actors are still struggling to find the right balance between decentralization of processes and decision-making, on the one hand, and institutionalized coordination and, where necessary, hierarchies, on the other.

Gaps between policy and regulation, research and extension, and in stakeholder communication have been observed. The policy level has the power to bridge these gaps. Great efforts to combat the adverse effects of climate change have been undertaken, and a range of new and advanced policies put in place. Nonetheless, in the future it is of the utmost importance to find and enhance synergies at all levels, e.g., research-development with well-designed projects and excellent ownership. CSA should also tie in with other development-related topics, e.g., health (via the food/nutrition security component in both) and environment.

It can also be said that there is a strong (almost exclusive) focus on productivity increase and adaptation, whereas mitigation is widely seen by stakeholders as a “nice to have” feature but not a core issue of CSA in Kenya. There is a need to make the mitigation component attractive to decision-makers and farmers alike. Mitigation must become an integral part of projects from the outset. This is crucial if CSA is to be taken seriously as a new and beneficial concept, and not merely as new wording for long-standing practices without innovation. Focusing on farmers and the benefits CSA can bring to their farm is another result of the policy research. Only if this principle is observed, will the long-term success of CSA interventions be viable.

That said, it also emerged that CSA cannot be handled as a blueprint but tailoring to the socio-ecological situation at hand and stakeholders must be involved. CSA is an umbrella term that needs to be filled by carefully taking the local context into account. Policy must ensure that this step is institutionalized. The big challenge here – based on recommendations from research and extension experts – is for policymakers to strike a balance between the framework definition of techniques and systems that genuinely qualify as CSA and the moment to leave flexibility to local stakeholders in order to create a locally adapted CSA system.

Another issue of major significance in both county interviews was the mode of cooperation between national and county level. Although considerable efforts have been made to increase transparency and open up communication at all stages of the project cycle, there is still room for improvement. Hidden agendas and abusive imbalances of power remain a huge barrier to good project implementation, which also blocks efficient cooperation in ongoing joint efforts. Given that county governments are at times still struggling with the implications of devolution, notably when it comes to coordination, implementing complex projects under devolution could be more demanding. Finding entry points and keeping in contact with the relevant stakeholders is now more challenging. It is therefore advisable to give high priority to coordination and communication between the county and the national level and to continue enhancing the processes involved.

Last but not least, monetary restraints are a common issue in project implementation. If CSA is to be a new or an additional priority for the counties, financing must be secured. Project planning needs to be aligned with existing coordination structures and take CIDPs into account in order to avoid parallel structures.

## **6.2 Farm level**

The results gathered in focus groups and individual interviews draw a picture of farmers who are well aware of the challenges they face in agricultural production and with changing weather patterns. The farmer groups that were interviewed had several ideas on how to react to such challenges, but the knowledge and the means to implement them were unevenly distributed among the farmers. While farmers in the focus groups presented an impressive pool of knowledge as a whole, it soon became evident that many of them struggled hard to dig deeper into their individual knowledge and perceptions of the associated attributes of the techniques. This indicates, on the one hand, the importance of existing and functioning socio-economic networks of community members, of enhancing knowledge

exchange and sharing ideas, and potentially of ensuring mutual support in times of need. On the other hand, it also points to a stronger need for education and training of farmers, both in terms of quantity and quality.

The results of the research further highlight that although the farmers came from the same study areas and often had similar backgrounds, their perceptions of the positive and negative attributes of CSA technologies and the importance they ascribed to them varied considerably. This confirms the expectation that promoting a one-size-fits-all strategy of CSA techniques for the farmers in the region will not suffice to accommodate the diverse needs and ideas that will eventually determine whether a farmer decides in favour of or against the adoption of new land management strategies. Moreover, careful analysis leading to tailored approaches and support is called for if upscaling climate smart technologies is to succeed in the region. This means taking into account individual farming situations with regard to availability of resources and productive assets, know-how and level of education, ecological and environmental farming conditions of the farms concerned, and the cultural or traditional farming objectives the farmer might pursue.

Despite existing disparities between individual farmer perceptions of benefits and cost of the various climate smart technologies, the research found an overwhelming appreciation of CSA technologies in general on the part of the farmers. Farmers ranked the benefits and advantages of the techniques higher on average than the associated cost and disadvantages. Nevertheless, only very few of the interviewed farmers had actually implemented the technologies on their farms. This further underlines that although many farmers are aware of and willing to try out new and improved farming strategies, the barriers they perceive to adoption, i.e., cost and accessibility of inputs, labor and skill requirements, represent a hurdle that many still find impossible to overcome.

While the results and recommendations may provide some good entry points for the promotion of outscaling climate smart technologies in Western Kenya, some fundamental challenges and open questions referring to specific technology choices and their effectiveness remain. While indicators have been developed for the assessment and comparison of one technology's climate smartness with another across the different categories of climate relevance (see ch. 3), there is no threshold or guiding principle to clearly indicate when a farm, let alone the agricultural sector, can be considered climate smart. The present study takes up the issue with the suggestion of promoting CSA techniques in packages in line with basic farm management categories.

Still, even with a full CSA technique package, farmers have no guarantee that this will build up sufficient farm resilience to deal with upcoming challenges from climate change. If farmers suffer from soil erosion, for example, they can decide on a solution from a variety of options, e.g., building terraces on a sloping field, planting erosion control plants such as Napier grass on the contour lines, or adopting agroforestry trees in the same field. So far, precise data and thus clear guidelines on the techniques or practices of greater benefit to individual farmer's goals, given their specific circumstances, is a rare commodity, while thresholds seen as sufficient to climate-proof the respective farm are non-existent. Similarly, if the farmer adopts Conservation Agriculture and water harvesting, there is no guarantee that this will retain sufficient soil moisture to carry the crops through a prolonged dry spell. This uncertainty about final outcomes poses a considerable challenge, and more so in the context of Western Kenya, where the unpredictability of weather changes is perceived by farmers as a key factor. While this emphasizes the importance of further research, it also highlights the need to complement any efforts to promote climate smart techniques with safety schemes that reduce the risk of crop and income losses, and help farmers to hold out until they can reap the benefits of their investments. Safety schemes should, for example, include the provision of index-based insurance schemes and enhanced weather forecasting and climate information, tailored to the needs and capacities of smallholder farmers.

CSA is gaining considerable currency on the international agenda, not least because it is seen as the ideal (and only?) track on which to achieve the ambitious global agricultural mitigation targets set by each country in the international climate policy negotiations of the Paris Agreement in 2015. Yet the realities of developing and lower middle-income countries, such as Kenya, clearly emphasize increasing productivity and improving adaptation to climate change, thus largely subordinating mitigation targets for the sector. If mitigation is set aside, however, the practical difference between CSA and previous concepts, such as SLM, remains blurry.

### **6.3 Research, extension and implementation level**

The current implementation of the research-extension linkage system in Kenya seems remote from the ideal vision of exchange, where all actors are satisfied with their roles and mutual acceptance is guaranteed. Not unlike other countries, the extension officer to farmer-relation (one to several thousand, see chapter 5.3.3) is highly disproportionate. In Ghana, for example, the average ratio is high-

er, with 1:1000 (Opare and Wringley-Asante, 2008). A similar situation was reported for Tanzania, which devolved power in 2000 and showed an unbalanced ratio of extension staff and farmers (Ahmad, 2008). To surmount these shortcomings, sizable supplementation of and coordination with extension from private, non-governmental and community-based organizations was suggested. Instead of a competitive attitude about the best or worst employer, coordination efforts should be strengthened for better coverage with EOs in the respective counties and sub-counties.

Dissatisfaction appears to be unequally distributed along the ladder of the unidirectional flow. KALRO and other research organizations conduct their work and publish their findings in databases that are accessible. Extension officers, the next link in the chain, feel abandoned by the government and the respective ministries, and see obstructions to their capacities. Here, the material developed by the SLE team, i.e., the technical factsheets, could contribute to overcoming one of the constraints in the day-to-day struggles of extension officers in Western Kenya and help to move forward the process of outscaling CSA.

The SLE team met only a small fraction of farmers that benefited from the knowledge distribution of their respective extension officer. The team did not cover those who had never worked with an extension officer. The number of farmers under the responsibility of one EO is too high to guarantee satisfactory service, while the attractiveness of the profession is declining, dogged by constraints in funding and career perspectives.

Another method of overcoming constraints is to bundle the results on CSA and the information gathered by the numerous actors in the agricultural research sector in Kenya. Platforms could either be web-based or in the form of a sophisticated library system in the Agricultural Training Centres (ATCs). The technical factsheets could serve both platforms, a digital version and a printed version, both giving valuable information on climate smart techniques for the area. International research alliances like CGIAR and ICRAF as a representative with headquarters in Nairobi aim to produce science-based knowledge on agroforestry and distribute and promote policy options (Vi Agroforestry, 2016). It would be advisable to benefit from synergies and integrate their results into the bundled knowledge platforms. Additionally, such a step would serve to fuel an intensive knowledge exchange with government representatives and encourage integration of the relevant findings into the curricula of extension officers. Further, it would be desirable to strengthen the knowledge exchange directly with the farmers and underline their integration into research approaches.

A limited budget appears to be the most severe constraint on strengthening the extension system. The Maputo Declaration on Agriculture and Food Security from 2003 suggested an investment of 10% of the national budget in the agricultural sector (NEPAD, 2003). Kenya has signed this declaration but is currently failing to meet the nationally pledged target by 1.5%.

A combination of an adjusted budget and greater inclusion of research outputs would help to reach the vision published in the sector performance standards to become a food secure nation with sustainable land management, modern urban infrastructure, and affordable and quality housing (Ministry of Devolution and Planning, 2015). A county and country-wide implementation and adoption of climate smart farming – but stressed by a strong extension service – could contribute significantly to achieving these goals and help smallholders to cope with the threats of climate change.

## 6.4 Synthesis of results

Overall, the results and discussions indicate that for CSA outscaling it is imperative to improve and upscale agricultural education and trainings services in the region so that farmers are equipped with the necessary skills and knowledge to make informed decisions. At the same time, however, they also show that some of the underlying causes of adoption barriers are more structural in nature and need to be addressed on a broader scale.

This impression also matches findings from the literature, which offers a variety of examples and case studies suggesting that high awareness and a consistently positive impression of and preference for different techniques among farmers may not necessarily lead to high levels of adoption (Cordingley et al., 2015; Emerton, 2016; Peterson, 2014). In this context, numerous studies have been carried out to examine the drivers of and barriers to innovative farming practice adoption, specifically targeting smallholder farmers (Barnard et al., 2015; Cordingley et al., 2015; Mutoko et al., 2015; Peterson, 2014; Shiferaw et al., 2009). The conclusions drawn from these studies strongly suggest that while information and capacity development at farm level is key, the surrounding conditions need to be equally favourable. Underlying structural barriers exist at all levels, from global to local, and ultimately discourage farmers from making sustainable investment decisions. These are, for example, unfavourable market conditions, policy and institutional barriers such as lack of infrastructure and low service quality, all of which further define the conditions under which decisions are made (Shiferaw et al., 2009).

Structural barriers often act as catalysts in causing and perpetuating a vicious circle of poverty, low productivity and land degradation, and represent a significant hurdle to technology uptake. In a synthesis of several studies on SLM uptake in Tanzania and Malawi, Emerton (2016) concluded that “without addressing these underlying economic causes of land degradation, or unlocking the constraints that they pose in terms of preventing people from being able to capture sufficient value-added and improve their livelihoods, many of the SLM options that are recommended to (or even demanded of) farmers are likely to remain beyond their reach” (p. 67).

Such underlying structural barriers to innovative farm management also need to be addressed in the context of Western Kenya. Here, farmers frequently face similar difficulties and challenges in their everyday farm operations. For example, many of them mentioned the difficulty of accessing financial means as a key barrier to technology uptake, indicating that both the provision of credits and market conditions work against them. Also, many of the inputs they require for enhanced farming practices were not always locally available or demanded long-distance travelling at high individual expense – an undertaking that the majority could not afford. It is evident that all of these structural factors need to be addressed and improved simultaneously in order to strengthen the farmers’ ability to make sustainable investment decisions that will lead to successful participation in the market economy and thus improve their livelihoods (*ibid.*). Unless stronger emphasis is given to addressing the challenges farmers face at all levels, upscaling CSA in Western Kenya could fail.

### **Lessons learnt from Innovation Diffusion Theory**

Some of the lessons learnt from chapter 3.2. for rapid innovation diffusion are summarized below and interlinked with the three thematic areas:

1. The provision of comprehensive information is indispensable to reaching a high adoption rate. It is important that the complex concept of CSA is broken down into “easily digestible” pieces. These are communicated to farmers by extension officers, who transform the academic information into farm-level language. Only if farmers are well informed and aware of the pros and cons of a specific practice or practice package can they form a well thoughtout opinion on the adoption of climate smart techniques.
2. If individual farmers decide to implement new techniques, it is essential that they are guided through the process, particularly if the techniques are labour-intensive or require technical expertise. In this phase of the adoption



stages, a strengthened extension service is key. Strengthened in this case entails finance, knowledge, didactic capacities and a reasonable supervision ratio.

3. Raising the number of multipliers is not simply a question of increasing the number of extension employees but also of ensuring the integration of more farmers into the extension system. There are a number of model farmers who host farmer field days. Reaching as many farmers as possible, however, requires trained model farmers, who can fuel farmer-to-farmer extension and establish networks with other farmers from different wards or even sub-counties.



## 7 Recommendations

Defining a coherent and comprehensive CSA strategy at county level encompasses *the identification and coordination of various activities and stakeholders* that cut across the agricultural sector and align national and county-level development goals. Broadly speaking, a strategy of this kind consists of several building blocks, each representing a sector (or thematic area) that calls for specific action to promote the outscaling of locally suitable CSA practices. Under appreciation of the information gathered on the status quo, opportunities and shortcomings in each building block, a strategy is designed by identifying entry points, prioritizing activities and allocating responsibilities to the respective decision-makers.

Following the suggestions of Cattaneo et al. (2012), *the building blocks of the CSA strategy* are closely aligned to those addressed in this study. They include:

- (i) *the government or policy level*, which is responsible for the design of coherent policies and institutional support for food security, and adaptation to and mitigation of climate change. This also involves creating the conditions necessary to obtain financial support for the implementation of the CSA strategy.
- (ii) *the private sector*, which needs to identify and adopt suitable climate smart practices along the agricultural value chain. As this study specifically targets smallholder farmers, it focused on the identification of suitable techniques at farm level, including incentives for and barriers to their adoption, given smallholder opportunities and constraints.
- (iii) *the research and extension level*, which is accountable for the generation and dissemination of information on climate variability and its implications, and on good practices for both adaptation and mitigation.

Once the necessary steps have been identified and prioritized, the final step involves securing the financial means and providing farmers with credits to undertake the required investments.

### 7.1 Prioritization of action

The results and discussions presented in the chapters above indicate that for the Western Kenya context, numerous opportunities for outscaling CSA were identified at policy, farm and research/extension levels, as well as the concomitant challenges. While this leads, accordingly, to a wide array of possible entry points

and recommendations for enhanced performance and promotion of CSA in the region, it is vital to step back from the level of detail and highlight some of the key priority fields of action that need to be addressed first. This is a crucial and necessary step if further, more detailed sector-based recommendations are to have their desired outcome.

Firstly, it became clear that the *county governments have to act as prime catalysts* in creating the required policy environment for outscaling CSA. Given that their chief planning tool is the CIDP, including and mainstreaming CSA as a priority development goal for the agricultural sector in the policy document constitutes the first step. This allows for access to and allocation of funds from the national government to promote CSA at county level. The approach chosen for CSA needs to be aligned with other national and county-level development goals, such as food security, employment creation and economic growth.

Once this policy framework has been established, county governments need to *prioritize the institutions to be strengthened and supported*. In other words, they must decide on how the newly allocated money is spent. The literature pointedly remarks that “the foundation for building adaptive capacity of rural communities is knowledge management. Improving the access to reliable information is key to facilitating adaptation in the form of the choices farmers make regarding crops, varieties and farming systems.” (Cattaneo et al., 2012: 16). And further, “[a]dopting CSA requires farmers to make both short- and long-term planning decisions and technology choices. Agricultural extension systems are the main conduit for disseminating information required to make such changes.” (ibid.). Given the weaknesses identified in the extension system of (Western) Kenya, *investment in extension service* management in general and the *capacity development and training of extension officers* in particular should be a key priority. The extension system, however, cannot provide all the information required. In parallel, the government must *invest in targeted research activities* on the cost efficiency and effectiveness of climate smart techniques, as well as in *improved infrastructure*, including that of *information and communication technology*, with specific reference to the collection, interpretation and dissemination of *data on climate variability* and its impact, as well as measures for adaptation.

Once the extension service is equipped with the relevant information and sufficient means to reach and advise the farmers, the latter can make informed decisions about investments in climate smart farming activities.

There can be no doubt that farmers still face considerable barriers and uncertainties with regard to technology adoption. Hence numerous other conditions need to be met in order to facilitate farmers in making their investment decisions. The more salient factors include the provision of credits and insurance schemes to reduce the risk of making investments under uncertainty and enhanced access to material inputs and well-functioning markets. Addressing and overcoming these structural barriers to technology adoption, however, can take time and effort to achieve. This calls for a strategy that will ease the transitioning phase, drawing on policy tools such as input subsidies, price guarantees or the promotion of community-based saving and credit schemes.

The following section will now turn to the three priority research areas, namely policy level, farm level and extension service including the research-extension linkage, to provide more detailed recommendations at each level.

## **7.2 Policy level**

At policy level, the essential ingredient for progress in implementing CSA is political will. Those in power at county level have made their interest in transitioning towards CSA abundantly clear – on condition that priority is given to the first two pillars and less focus on the third pillar, mitigation. This approach is in line with the national strategy on CSA and also characteristic of a developing country, where food security is a persistent issue. Since there is no point in overriding or ignoring this strategy as an external actor, it is about finding and promoting CSA techniques that bring substantial benefits for the first two pillars and at the same time prevent the third pillar from lagging behind. The techniques presented and discussed in this report are a good starting point but can of course be complemented over time.

The second fundamental recommendation given here refers to the concept of CSA: Our research has shown that a wide array of techniques make up CSA and that the concept is too complex for a generally accepted definition of what is and what is not climate smart. It is therefore crucial for stakeholders and actors to engage in discussions and keep communicating. One solution here might be to institutionalize a forum on CSA that is kick-started with a conference or meeting that brings the relevant stakeholders together. This would also be the right place to discuss best practices and to fine-tune the concept of CSA, specifically how best to apply it in the context of Western Kenya. The CSA Task Force that exists at national level would be the right format to take over and coordinate this task. It

would, however, need to be numerically strengthened and supported if the task is to be fully covered.

The report has also highlighted that the CSA framework and strategy at national level is quite advanced in Kenya. What is lacking is its implementation at county level. In order to speed up CSA implementation, the link and communication between national and county level has to be reinforced. This could work with institutionalized meetings and the appointment at both levels of contact persons responsible for communication. Also, the release of money from funds and budgets could be linked to ensuring stakeholder meetings, feedback loops and capacity building. In order to guarantee clarity, consistency and operationalization between actors and stakeholders on CSA, county governments should cooperate across ministries and government institutions, and with national and international development organizations, NGOs and research institutes in the interests of aligning their strategies on agricultural development. Ideally these communication loops would be institutionalized, e.g., via channels such as ASDSP.

The policy level is also the level where the “development smartness” of a CSA strategy is defined. This means connecting interdisciplinary research, practice and policy. Research, agricultural activities and policy development should be integrated right from the start. This improves decision-making at all levels because the decisions are based on broader scientific evidence and field experience. In such a framework, research also contributes to extending the scientific basis of CSA by contributing baseline data to measure, report and verify the effectiveness of CSA practices.

Being “development smart” also means to pursue lean structures and not build parallel administration and implementation structures for CSA alone. As many connected topics as possible should be identified, including food security, health and environment. Ties can be made, e.g., via joint projects. Building synergies with these topics and CSA will ensure its role in the development context. Emphasizing practices that simultaneously address resilience/adaptation, mitigation/low emissions development, and food and nutrition security is crucial. CSA actions and processes must fit into the larger Kenyan development vision, including the enhancement of employment, income, nutrition status, education, and market opportunities, and contribute to overcoming social inequities. CSA is smart precisely because it addresses a range of key development issues. Thinking, planning and implementing beyond the horizon of individual projects is likewise imperative and will increase the prospect of CSA becoming a successful venture.

The consequences and hardships of devolution for the policy level have been discussed extensively. On the other hand, devolution represents a golden opportunity. Its momentum can be used to upscale CSA. Since CSA is anything but a one-size-fits-all concept, it needs to be contextualized. This is (only) possible under devolution, with more power at county level and the opportunity to tailor development plans to local needs. At county level, participatory decision-making could be exploited to make maximum use of knowledge from the rural communities.

The policy level is likewise responsible for creating a framework for two neighboring sectors, both of which are key to the successful upscaling of CSA: supplying reliable and available weather and climate forecasts for agriculture and developing insurance and finances schemes beneficial to smallholders. Another asset that eases farming under climate change conditions is the mapping of suitable locations for certain crops. This would have to go hand in hand with research. These issues have a strong bearing on CSA implementation and would greatly enhance its uptake.

### **7.3 Farm level**

As outlined earlier, CSA has to be thought of and implemented in an integrated manner. The first recommendation is to always think of and communicate CSA as a technique package that works better the more techniques are applied. Much can be learned from the climate smart village in Nyando: Only farmers that implement a minimum number of climate smart techniques are considered to have a climate smart farm. An incentive scheme for farmers to earn the climate smart label should be installed. This could, for example, consist of farmer support in the form of inputs or capacity development by extension services.

Payment for carbon mitigation schemes cannot be the sole incentive for farmers to adopt CSA techniques, given the low returns they generate. The recommendation at the moment is not to prioritize payment for carbon schemes as a CSA upscaling incentive. If, on the other hand, a payment scheme is nonetheless pursued, payment – and especially certification schemes – would have to be simplified to ensure genuine benefits to farmers. Subsidies for the certification process could be a solution here.

In order to account for the integration of levels and dimensions to which this report refers, moving beyond individual practices and thinking holistically in terms of farm and landscape systems and approaches is a must. More specifically this

means supporting farmers on their path to a climate smart farm, similar to those promoted by the climate smart villages (see chapter 3.1 and 5.2), rather than merely promoting individual techniques. Integrating the production of livestock, fish, crops and trees on farms or throughout the entire landscape can enhance productivity, strengthen the resilience of farming systems, and reduce and remove greenhouse gas emissions (FAO, 2013).

Any efforts to outscale CSA must always be embedded in the local context, culturally, socially and environmentally. It is therefore of utmost importance to remain in constant contact with local communities when implementing CSA projects. A highly practical recommendation to support the diversification of crops and nutrition here is to provide cooking recipes and cookery courses in order to embed new crops into the local food culture. Focusing on gender helps to take the special needs of women and youth into account.

Specific attention should be paid to building the capacity of women, men and youth as those who manage natural resources. Farming skills, as well as leadership and facilitation skills can be built with the support of local groups that tailor climate information to community needs and make the necessary materials available (Chesterman and Neely, 2015).

If CSA upscaling is to be successful, the bigger picture must be taken into account, i.e., the standard situation of smallholder farmers. The majority of them are locked in a vicious circle of low agricultural productivity, poverty and land degradation, leaving them little or no scope to adapt but merely to struggle for survival by (over)using the natural resources at their disposal. Without addressing the underlying economic constraints farmers face, including access to knowledge and other inputs, markets and financing, CSA techniques will most probably not be adopted on a wide scale. Policies addressing CSA must be designed to address these challenges.

Farmers will have to learn the truly best practices of CSA techniques – in general and for their own purpose. This could, for example, mean confining the use of herbicides to an absolute minimum or implementing an agroforestry system with locally suitable trees. The techniques can only be considered genuinely climate smart if these best practices are followed. Cooperation with the GIZ project AT-VET might be a way forward on this issue. The task of teaching farmers best practices also lies with the extension officers. Recommendations for their role are highlighted in the next chapter.



## 7.4 Research, extension, implementation and their linkages

Underpinning the backflow of information from farm level to research and government is another building block at the centre of a strategy to upscale CSA. Overcoming the unidirectional flow of information is a prerequisite for the research level to work on the most pressing issues farmers face in their daily lives. This will also ensure that knowledge on suitable adaptation methods available on the ground will not be lost and can be upscaled. All of these benefits can be obtained by using participatory methods that allow the voice of farmers and extension officers to be heard.

The second recommendation for this section refers to coordination of the curricula for extension services. Neither research results from KALRO nor CIAT have been integrated systematically into the curricula. In order to overcome this gap in knowledge transfer, regular stakeholder meetings should be installed. Additionally, a position in MoALF at national level could be created to coordinate and bundle relevant findings and subsequently incorporate them into the current curricula. This would ensure that extension officers' vocational training is fully up to date.

Also, training material used by extension officers must be coordinated more carefully. To achieve this goal, a central online platform where, e.g., brochures and manuals can be downloaded could be created or reinforced. The Agriculture Information Centre (AIC) appears to already have a central platform. This requires greater visibility and could become a knowledge hub to which extension officers can turn. Capacity development enhancement calls for short specialized courses provided in partnership with international actors, stakeholders with expertise, and research entities to be made available to extension officers on a regular basis.

The upscaling of CSA cannot function without the work of extension officers. Unfortunately, the image of this job is somewhat lacklustre and fails to appeal to young people in Kenya. Tackling the issue calls for a twofold approach: the first is to offer more attractive working conditions such as higher salaries and increased benefits as an incentive for long-term employment. The second, and this might even be more significant, is to change the image of extension officers' work and convey to young people the value and diversity of the task.

Last but not least, further research on applied CSA techniques is necessary: notably in the context of applicability in an integrated landscape approach that includes the further development of indicators, mutual trade-offs and their assessment and monitoring in the field, as well as their continuous adjustment to upcoming challenges posed by ongoing climate change.



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## Annex

### Annex 1: Explanations of CSA techniques

*Agroforestry*, as practiced by farmers and recommended by extension officers in the focus groups, refers to the intercropping of multi-purpose trees into or along the crop fields, most commonly practiced in maize and bean fields. Mostly, farmers would not plant the trees systematically, but have only a few of them distributed over their fields. Trees were primarily planted for fodder, fruit production, fuel wood and timber (species including e.g. gravelia, caliendra, leucenia, macemia, sesbania, jacaranda, cypress, caradali; banana, avocado, citrus). Some farmers also mentioned small eucalyptus plantations of approx. 0.2 acres as their agroforestry practice.

*Certified seeds (drought tolerant varieties)* were used by almost all farmers, who said to use early maturing maize varieties from Kenya Seed Company and Western Seed Company. Some also mentioned that they would shift to grow more sweet potatoes and sorghum as drought tolerant varieties.

For *compost and use of manure*, farmers collect the livestock manure and urine typically from the sheds of cows, goats and chicken ("all animals except cats and dogs", in the words of one farmer), either to leave it untreated and work into the soils directly, or to prepare compost. To make compost, farmers choose a spot of typically around 4–8 square meters in size that they restrict with wood poles. They bring crop residues from the fields and add green cuts as well as tree leaves from around the farm (ideally using leguminous plants such as tithonia, mulatu grass or desmodium). They add livestock manure, soil and sometimes ash and/or egg shells, then leave the heap to decompose and turn it every three to four weeks. Farmers say the compost is ready to use after three months. Alternatively, farmers also described to prepare compost in a hole in the ground, which is covered during the decomposing process. Others also used a special chemical input that accelerates the composting process to be ready after one month.

*Conservation Agriculture (CA)* refers to a platform technology consisting of three sub-techniques, namely no-till or reduced tillage, mulching or use of cover crops, and crop rotation and diversification. The descriptions on how CA was practiced varied from farmer to farmer and also differed among extension officers. One of the core differences lies in the use of chemical herbicides for weeding by some, and the use of manual or shallow weeding by others. Also, some farmers

would practice mulching, i.e. the application of plant materials as soil cover, using crop residues or tree leaves. Others would rather plant a cover crop as mulch, such as lablab, cowpea, groundnut or desmodium, thus also avoiding that the mulch would be eaten by termites or ants. Most farmers had learned about CA during field days, while only very few were actually practicing it. One farmer in Kakamega described how she learned CA during a field day (but did not practice it herself): “You start to dig individual deep holes in a row with small spacing in the fields, add three seeds of maize and some beans (the intercrop being planted in the same hole), take two hands of manure per hole and cover it with soil. Between the rows, you do not weed normally but practice shallow weeding and leave the residues on the field. Each plant basin can be used for two seasons before shifting the rows into the middle for the soil to recover.” Crop rotation was almost never mentioned by the farmers when describing the technology.

*Crop rotation* was reportedly practiced in horticulture, where farmers alternate vegetable crops, and sometimes on the cereal crop fields. Farmers stated to rotate maize with sorghum, sweet potatoes, beans or groundnuts, sometimes also with vegetables. Yet, crop rotation did not seem very common, especially some of the subsistence farmers felt that their lands were too small and feared to jeopardize their food security if they did not plant maize on their entire land. It was also regarded as very knowledge-intensive.

*Improved fodder management* was defined by farmers as either the cultivation of fodder plants for livestock (typically Napier grass, boma rhodes or desmodium), or, in a few cases, as hay and silage making, to improve fodder availability during critical periods.

*Improved livestock breeds and management* involves cross-breeding of local with improved cows, usually through artificial insemination, and keeping them in improved cow sheds (containing a solid roof and concrete flooring). Cross-breeds were popular among the dairy farmers in the focus groups. They stated to result in an increase of dairy production while at the same time retaining many of the valued qualities of local breeds, specifically in terms of tolerance to local pests and diseases. Keeping improved cows was regarded by some farmers as knowledge- and labour-intensive, by others as easy to manage. Typically, farmers would keep improved cows in their sheds all day and feed on cut and carry practice. Improved cows were also said to require higher amounts of quality fodder and regular medical checks, yet not all farmers fully complied with these requirements.

In *intercropping*, two or more different crops are planted in the same fields, often in alternating rows or alternating by crop. It was common practice for all farmers in the focus groups, who described intercropping as an old local farming tradition. Typically, farmers would intercrop a cereal crop with a leguminous crop, such as maize or sorghum with beans, cowpea, desmodium or groundnut. However, intercropping is practiced with a variety of crop combinations, also including roots and tuber plants, such as sweet potato.

*Mulching and cover crops* can also be practiced without the remaining CA components (which seemed to be more common than doing CA).

The *Push-Pull* technology was described as integrated pest management strategy, whereby maize was intercropped with desmodium to repel stemborer pests while at the same time reducing striga infestation on the maize plants. Farmers would also plant Napier, mulatu grass or boma rhodes around the field, to attract the pests away from maize. The inter- and trap-crops were much appreciated as good fodder material for livestock. The technology was well-known among farmers in both Kakamega and Siaya and reportedly has been promoted via different NGOs, research institutes such as icipe (International Centre of Insect Physiology and Ecology, based in Nairobi) and extension officers. Several farmers said they received the seed inputs for free. However, although many farmers knew the technology, only a few of them also practiced it. In one farm, the farmer only implemented this technology on a small plot, leaving her remaining plots under maize-only cultivation. This added to the impression that farmers valued this technology predominantly for fodder.

*Soil testing and liming* refers to the testing of soil samples to establish the pH-level, usually followed by the application of limestone to reduce soil acidity. Farmers were keen to test their soils “to identify areas in [their] land to know the best places for different crops” (Farmer in Kakamega). Some farmers found this practice to be the prerequisite for any further farming activities, as testing and liming would allow to reduce soil acidity and thus improve nutrient uptake for the crops. Yet, the service is reportedly hardly available and was regarded as expensive, and only a few of the group participants had already benefited from the practice.

*Terracing* stands for the physical construction of soil terraces on steep or sloping lands, used to control soil erosion and water run-off. Construction is labour intensive and requires digging and shifting soil material and stones in the fields to create level terraces along contour lines. Some farmers in Siaya mentioned they could only build and maintain the terraces with help from hired labour or through

a labour-sharing arrangement with their neighbours. The width of terraces depends on the slope gradient. Sometimes, farmers would also plant Napier or similar grass plants at the terrace edges to improve the stability and increase control of soil erosion.

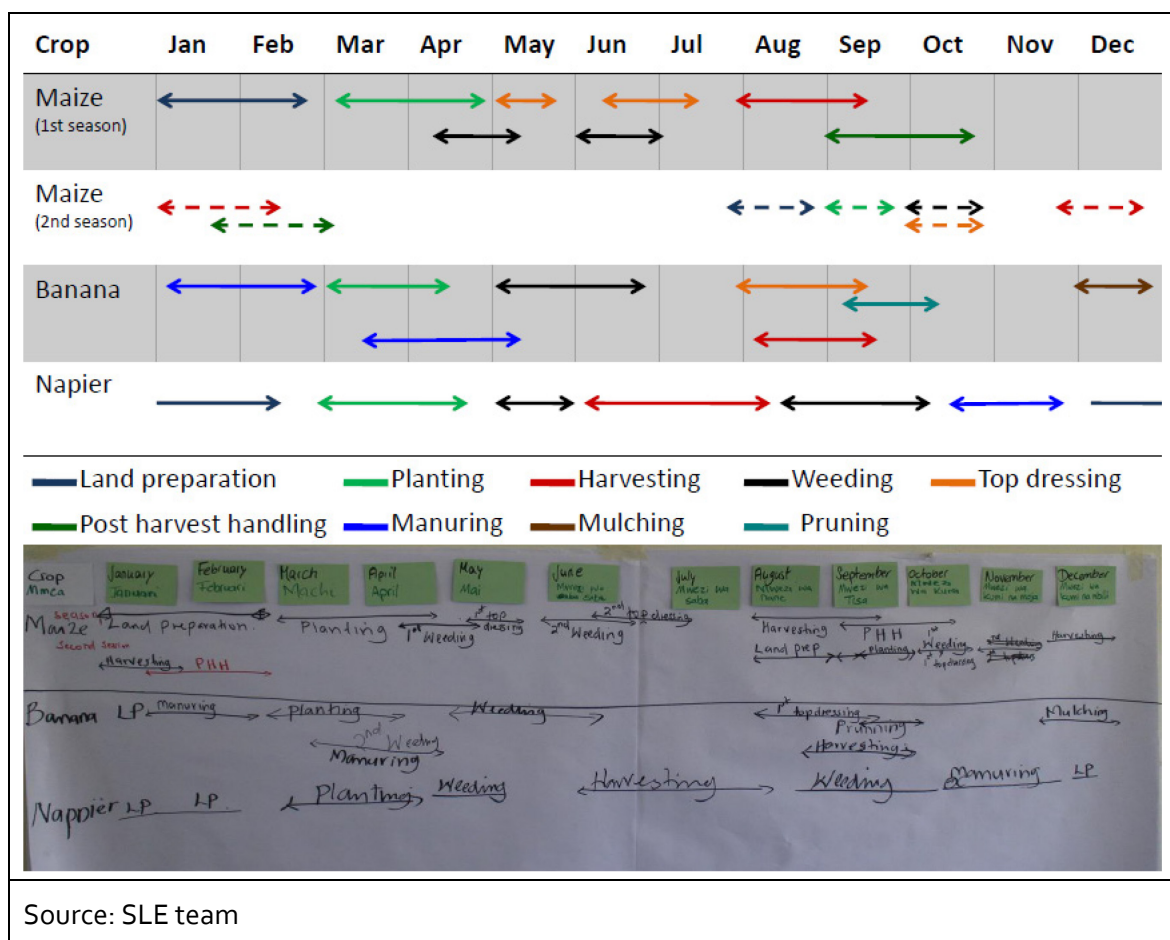
*Water harvesting* was regarded as a very attractive technology by many farmers, yet few of the focus group participants actually practiced it, or knew how to do it. In the words of one farmer, "I admire it, but my hands are closed." Some of the horticultural farmers had heard of roof water catchment, where rain was collected from the roof in a plastic basin. Several others would describe this technology as digging a large basin (approx. 8–16 square meters in size, and 1–2 m deep) in the field and install a polythene cover on the ground to collect the rainwater. This could then be used for e.g. bucket or bottle irrigation, or for feeding livestock. Other common ways of water harvesting were zai pits, where the farmers would dig small basins around the crop plants in the fields such that they would retain more water during rainfall.

## Annex 2: Counties and sub-counties

Twenty farmers for ELMO were chosen from the following sub-counties:

County	Kakamega (AEZ 1)	Siaya (AEZ 2)
Sub-County	Shinyalu Mumias-East Matungu	Alengo Usonga Rarieda Bondo Gem Ugunja* Ugenya*
* sub-county assigned to AEZ 1		
Source: SLE team		

## Annex 3: Seasonal Calendar for the main crops in Kakamega



Source: SLE team

**Annex 4: Interview reference list**

<b>Interview Number</b>	<b>Name of Institution</b>	<b>Date</b>	<b>Location</b>
1	CIAT (2 participants)	04.08.16	Nairobi
2	CIAT	12.08.16	Nairobi
3	ViAgroforestry	30.09.16	Telephone interview
4	Dairy Farmer in Mumias East	11.10.16	Telephone interview
5	Agricultural Sector Development Support Programme (ASDSP)	22.08.16	Kakamega
6	MoALF Kakamega	29.08.16	Kakamega
7	MoALF Siaya	06.09.16	Siaya
9	CIAT	12.09.16	Maseno/E-mail communication
10	FAO	11.08.16	Nairobi
11	GIZ (ATVET) (2 participants)	09.08.16	Nairobi
12	KALRO(several participants)	30.08.16	Kakamega
13	GIZ	16.08.16	Kisumu
14	GIZ	16.08.16	Kisumu
15	ViAgroforestry	24.08.16	Kisumu
16	Deutsche Welthungerhilfe		Kakamega
17	Extension Officer	11.11.16	Mobile phone
18	Extension Officer	11.11.16	Siaya
19	Extension Officer	26.08.16	Kakamega
20	Extension Officer	26.08.16	Kakamega
21	Extension Officer	26.08.16	Kakamega
22	Extension Officer	26.08.16	Kakamega
23	Extension Officer	26.08.16	Kakamega
24	IASS (several participants)		Potsdam

## Annex 5: Working schedule

Calendar week	Activities	Location
31–32	Exchange with colleagues from CIAT, visit further actors, presentation and discussion of study concept Literature review Training on ELMO Expert interviews	Nairobi CIAT-ICIPE
33	Kick-off Workshop GIZ Kisumu – presentation and discussion of study concept, exchange with further actors Transfer to Maseno/field visit of CIAT long/short term trials Expert interviews	GIZ Offices Kisumu CIAT office Maseno Field plots Maseno
34	Focus Group Discussion with Extension Officers Training of Extension Officers for facilitation of the Farmers Focus Group Discussions Parallel Farmers Focus Group Discussions	Kakamega
35	Parallel Farmer Interviews Kakamega (ELMO) Expert Interviews Training on data analysis for ELMO Focus Group Discussion with Extension Officers Siaya Training of Extension Officers for facilitation of the Farmers Focus Group Discussions	Kakamega, Maseno, Siaya
36	Two parallel Farmers Focus Group Discussions in Siaya Parallel farmer interviews (ELMO) Expert interviews	Siaya
37	Data analysis Further expert interviews	Kisumu
38	Excursion week	Kenya
39–41	Data analysis and writing of report	Diani
42–44	Presentation of preliminary results GIZ Presentation of preliminary results CIAT Presentation of preliminary version of factsheets GIZ Departure to Berlin	Kisumu Nairobi



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